Mortality among Immigrants and their Descendants in England and Wales

Thesis submitted in accordance with the requirements of the University of Liverpool for the degree of Doctor in Philosophy by:

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Introduction

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1.1. Introduction

The *migrant mortality advantage* posits that immigrants have low mortality relative to non-migrants living in the host country (Anson, 2004), even among immigrants who have a lower socioeconomic status (Razum et al., 1998). Over time, the advantage is thought to diminish as mortality among immigrants attenuates to the higher mortality rate among the host population (McDonald and Kennedy, 2004). Among descendants of immigrants, the mortality advantage can persist, wear off or even reverse (Tarnutzer and Bopp, 2012). While immigrant mortality has been studied before in both the U.S. (Abraído-Lanza et al., 1999; Palloni and Arias, 2004; Turra and Elo, 2008; Ruiz et al., 2013) and Europe (Razum et al., 1998; Anson, 2004; Khlat and Courbage, 1996; Deboosere and Gadeyne, 2005), the actuality of the *migrant mortality advantage* remains contested and its primary causes poorly understood. The aims of the thesis are:

1 *To examine mortality patterns among immigrants and their descendants living in England and Wales.*

2 *To investigate causes of mortality differences between immigrants, their descendants and the England and Wales-born population.*

Why is it important to study mortality among migrants? The UK, along with other western countries, has a growing foreign-born population, doubling from 7% of the UK population (3.6 million) in 1991 up to 14% (7.5 million) as of 2011 (Smith, 2013). In 2011 a fifth of the UK population identified as an ethnic minority (Jivraj and Simpson, 2012) and of these 1 in 3 was born in the UK (Dustman et al., 2011). This growing mobility and rise in net migration over the past two decades has increased the share of immigrants living in and the number of their descendants being born in the UK. Migrants are not homogenous (Rechel et al., 2013). Their diversity in terms of country of birth, ethnicity, socioeconomic status, health behaviours, length of residence and period of arrival is profound and has implications for health status and health needs, entitlement and access to healthcare, health insurance schemes and pension systems (Jayaweera and Quigley, 2010). Explicit migrant health policies are required in all countries which have a large foreign-born population (Rechel et al., 2013). A lack of understanding about the factors which influence mortality patterns among migrants and ethnic minorities seriously challenges the ability of policymakers to address migrant's health needs (Jayaweera, 2014). Growing proportions of migrants in western countries also suggest that their mortality patterns will carry an increasing weight on national mortality levels of their host country (Guillot et al.,

2016) especially when migrants both contribute to as well as mitigate population ageing (Shaw, 2001).

How does this thesis improve our understanding of the *migrant mortality advantage*? Mortality among immigrants is a consequence of several causes acting at various stages of the life course (Deboosere and Gadeyne, 2005). The primary causes include *the healthy migrant effect*, which states that migrants select by good health into migration, creating a uniquely robust population with a low mortality risk (McDonald and Kennedy, 2004). C*ultural factors* posit that migrants practice health-protective, culture-specific behaviours which work to produce a low mortality risk (Abraído-Lanza et al., 1999). The *immigrant health transition* theorizes that non-western migrants experience a mortality advantage because on arrival they benefit from a decrease in mortality risk from infectious diseases (the main cause of death in the origin country) through access to better quality healthcare and improved environmental conditions. This precedes the gradual influence that chronic diseases (the main cause of death in the host country) has on mortality. The analysis of migrant mortality by sex, cause of death, generation, over age and in relation to their socioeconomic characteristics will help to improve our understanding of these causes.

Additionally, two confounding factors exist in *health-related remigration* and *registration uncertainty*. Health-related remigrations include returns to the country of origin at older ages, which reflect a desire to die in the place of birth (a *salmon bias effect*) and at younger ages based on poor general health (an *unhealthy remigration effect*) (Razum et al., 1998). Both can lead to an undercount of deaths in host country statistics (Turra and Elo, 2008). Registration uncertainty relates to the accuracy and timeliness of move reporting, positing that uncertainty in the entry and exits dates of migrants lead to an overestimation of their time-at-risk in the host country. Both of factors can downwardly bias mortality rates, leading to artificially low mortality (a data artefact). These two factors are seldom accounted for in studies of immigrant mortality. This creates uncertainty surrounding the actuality of a migrant mortality advantage. This thesis also improves our understanding of migrant mortality by explicitly modelling and adjusting for registration uncertainty and by investigating for health-related remigration among migrants.

By investigating these two confounding causes, the findings from this thesis will be able to definitively show whether migrants who live in England and Wales experience a true migrant mortality advantage. If the mortality advantage is not a data artefact created by false patterns in the data (i.e. registration uncertainty and health-related remigration), we can be confident in results from other international studies which find a migrant mortality advantage, particularly those which use register-based data prone to registration errors. We can also be confident that some combination of selection effects, cultural factors and health transition operate to produce the advantage. There are currently few large-scale, robust studies of immigrant mortality and this thesis will offer a significant contribution to literature in this growing field of demographic research.

In a UK context, available data on immigrants' mortality, particularly large-scale quantitative data that can be linked to socioeconomic characteristics, is limited. Information on country of birth (which can be overlooked for ethnicity) is often not included in routine administrative systems (Jayaweera, 2014). The Office for National Statistics (ONS) Longitudinal Study (LS) provides access to large-scale, longitudinal data which spans over four decades and links life event data (on births, mortality and migrations) with census data (including data on country of birth, ethnicity and a diverse array of sociodemographic characteristics). Previous research into migrant mortality in the UK has been conducted, but is based on smaller time frames (Marmot et al., 1984; Wild and McKeigue, 1997), cross-sectional data (Wild et al., 2007) or focuses only on ethnic differentials in mortality (Rees et al., 2009; Scott and Timaeus, 2013). Given the growing proportion of foreign-born in England and Wales, it is surprising that no large-scale study of migrant mortality has been conducted. The thesis will contribute reliable findings from a large-scale, longitudinal dataset on migrant populations in England and Wales. Further, by studying mortality across a diverse range of immigrant groups, the thesis will provide important information on variation in the size and scale of the migrant mortality advantage by country of birth.

1.2. Theoretical framework

A migrant mortality advantage has been observed among immigrants living in many western countries: Germany (Razum et al., 1998), Belgium (Anson, 2004; Deboosere and Gadeyne, 2005), France (Khlat and Courbage, 1996; Boulogne et al., 2012), New Zealand (Hajat et al., 2010), Australia (Powles, 1990; Kouris-Blazos et al., 2002) and Canada (McDonald and Kennedy, 2004) although rates and risks vary according to the country of birth, ethnicity and socioeconomic background (Norredam et al., 2014). In the U.S., evidence of a *Hispanic mortality paradox*, where immigrants have lower mortality despite a lower socioeconomic background (Razum et al., 1998) has been consistently observed (Abraído-Lanza et al., 1999;

Palloni and Arias, 2004; Abraído-Lanza et al., 2005; Markides and Eschbach, 2005; Turra and Elo, 2008; Ruiz et al., 2013). Evidence for a socioeconomic mortality paradox has also been observed in Europe (the *Mediterranean mortality paradox*) (Khlat and Darmon, 2003). Despite many empirical studies which observe a migrant mortality advantage, some studies observe high relative mortality, particularly among those immigrants who migrate from neighbouring origin countries (Sundquist and Johansson, 1997; Sundquist and Li, 2006; Wallace and Kulu, 2014).

Among the descendants of immigrants, empirical research is limited because in many western host countries, descendants have not yet reached the ages of high mortality (Scott and Timaeus, 2013). However, the research that has been conducted tends to observe an inter-generational convergence from the mortality level among immigrants to the mortality level among the host population for descendants. In Switzerland, Italian immigrants have low mortality relative to the native Swiss, but their male descendants have high mortality and their female descendants have comparable mortality to the host population (Tarnutzer and Bopp, 2012). In Belgium, Turkish and Maghrebin immigrants also have low mortality relative to native Belgians, but their descendants have similar mortality to the host population which is high before adjusting for educational differences (De Grande et al., 2014). In the U.S., U.S.-born Hispanics, Blacks, Asian and Pacific Islanders and non-Hispanic whites all have higher mortality than respective foreign-born groups (though only U.S.-born Blacks have higher mortality relative to the White U.S.-born) (Singh and Siahpush, 2001). Conversely, the descendants of Turkish immigrants in Germany, like the first generation, have low mortality (Razum et al., 1998) and report lower chronic illness rates and rate their health better than their German host population (Kotwal, 2010).

1.2.1. The immigrant health transition

A framework which has garnered significant attention in recent years and will provide the basis for this review is the immigrant health transition. Relative to the epidemiological profile in western countries, non-western immigrants move from a country in an earlier phase of health transition (Razum, 2006). On arrival, they immediately benefit from healthcare for treatment of infectious, maternal and childhood diseases and develop a lower risk of death from these diseases due to improved hygiene and environmental conditions (Spallek et al., 2011). Further, immigrants have been exposed to fewer chronic disease risk factors in the country of origin. While new risk factors emerge in smoking, poor diet and a sedentary lifestyle (Spallek et al.,

2011) it takes time to acquire a western lifestyle (POST, 2007) and behavioural changes like smoking can predate mortality changes by decades (Zaman and Mangtani, 2007). Immigrants thus experience a health transition that is immediate in terms of the reduced risk for infectious diseases (the main cause of death in the origin country) and only gradual in the growing role of chronic diseases (the main causes of death in the host country) (Razum and Twardella, 2002).

As a result, non-western immigrants experience a mortality advantage years after migration and adaptation to western life (Razum, 2006). Chronic diseases *will* become the major cause of death and low mortality *will* converge to the mortality level among the host population, but only after a considerable lag period (which can be decades) (Spallek et al., 2011). An additional consequence of the health transition is that immigrants can still have high mortality for specific diseases as a result of their early life exposures in the country of origin (infections or deprived living conditions) or through their genetic susceptibility to disease and any gene-environment interactions (Spallek et al., 2011). Immigrants move through different phases of this health transition (*pre-migration*, *migration* and *post-migration*) throughout their life course. While western immigrants do not experience a health transition, they may still have lower mortality through the operation of selection effects, cultural factors and health-related remigrations. These other factors can be positioned in the relevant phase of the life course in the health transition framework. The three phases are outlined with possible factors placed in each phase below.

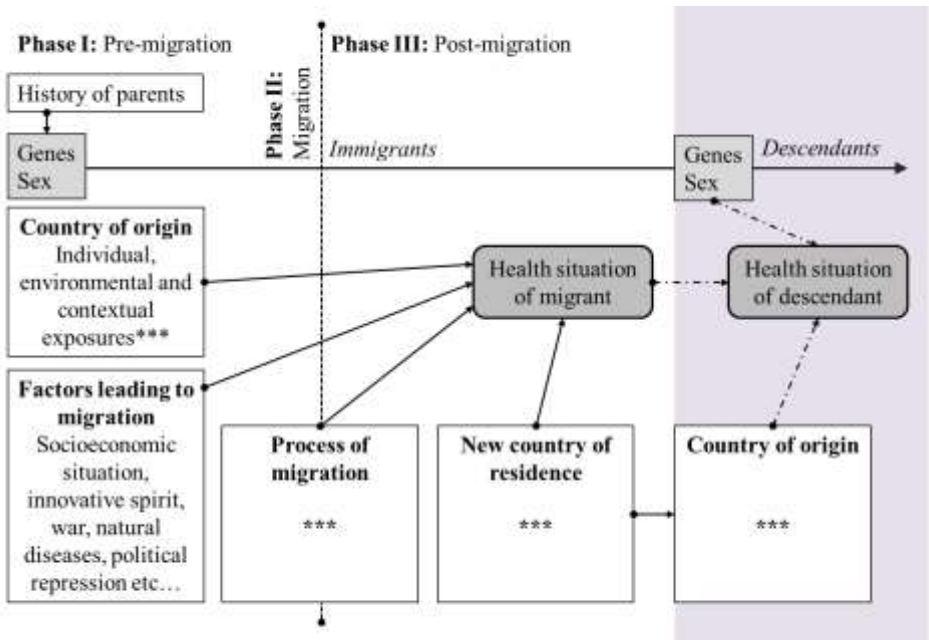

Figure 1.1. Different exposures during the lifecourse on the health of immigrants (*based on Spallek et al., 2011*).

1.2.2. Phase I: The period before migration

Genetics

The first phase (see fig 1.1), the period before migration, suggests that immigrants are exposed to factors not faced by the majority population in the host country such as exposures during childhood (e.g. infection by Helicobacter pylori and hepatitis and risk for stomach and liver cancer) and deprived and insanitary living conditions (Spallek et al., 2011; Boulogne et al., 2012). Genetics also influences mortality and the role of genes ranges from genes that directly determine the incidence of certain diseases to those that interact with other genes and their environment to cause disease (WHO, 2015). Genes are known to influence the incidence of cancers, CVD and some respiratory diseases (Gupta et al. 2006; Dong et al., 2008; Castaldi et al., 2010). High CVD mortality among South Asians, for example, is linked to their genetic susceptibility (Wild and McKeigue, 1997; Gupta et al., 2006). The *thrifty gene* and *adipose tissue hypotheses* posit a gene-environment interaction among South Asians whereby they develop CVD risk when exposed to a western lifestyle (Gupta et al., 2006; Sniderman et al., 2007).

Cultural factors

Culture-specific behaviours (diet, smoking, alcohol, exercise, and reproductive behaviours) (Singh and Siahpush, 2001) learned in the country of origin may create a cultural buffer which initially protects immigrants' health status after arrival in the host country (Jasso et al., 2004). Low mortality among Moroccans (particularly men) in France, for example, is influenced by low alcohol intake (which protects against cancers of the mouth, pharynx and oesophagus), a fruit and vegetable-rich diet (cancer of the intestine and stomach) and fertility (breast cancer) (Khlat and Courbage, 1996); behaviours learnt in the country of origin. A Mediterranean diet in South Europeans may have health-protective features (Khlat and Darmon, 2003). It has been observed to lower chronic disease incidence, with reductions in cardiovascular (9%) and cancer mortality (6%) (Sofi et al., 2008) and may offset the effect of other chronic disease risk factors such as smoking and a sedentary lifestyle (Powles, 1990; Kouris-Blazos, 2002). In the U.S., Latino immigrants have been shown, after adjusting for sociodemographic factors, to drink and smoke less than the U.S.-born (though they were less likely to exercise) (Abraído-Lanza et al., 2005).

1.2.3. Phase II: The migration process

Selection effects

Migration is a phase where immigrants may select on the basis of good health (Franzini et al., 2001), as proposed in the healthy migrant effect. The effect can be so strong that mortality is lower than the host population irrespective of the socioeconomic background (Deboosere and Gadeyne, 2005), but can vary depending on the motives for migration (education, health, work, family reunification) (Boulogne et al., 2012). Some question the selection effects lasting long enough to explain low mortality decades later (Khlat and Darmon, 2003) and the ability of young people to select based on future susceptibility to chronic diseases when symptoms do not present for decades (Uitenbroek and Verhoeff, 2002). Methodological issues exist in the inability to study immigrants before their migration and consequently, the lack of a valid reference category (non-migrants in the country of origin) (Rubalcava et al., 2008). The only direct study of selection investigated Mexicans from the same sending area before and after migration and could not detect selection effects (Rubalcava et al., 2008). Selection does not play a role in mortality among descendants (Harding and Balajaran, 1996). However, if genes contribute to immigrant selection, good health may be inherited by descendants (Spallek et al., 2011).

Immigrants also select for traits which help them to cope with the physical and psychological challenges of migration (Gushulak, 2007). Immigrants are associated with traits like courage (Schiffauer, 1991), ambition, motivation (Uitenbroek and Verhoeff, 2002), social adeptness (Razum et al., 1998), risk-averseness (Lindstrom and Ramírez, 2010), drive and tenacity (Li and Heath, 2007). Descendants can inherit these traits through parents (Li and Heath, 2007). However, if they do not, they may be less capable of overcoming both the physical and psychological challenges associated with an ethnic minority status. Some governments can also health screen immigrants (McDonald and Kennedy, 2004; Kibele et al., 2008). However, the numbers denied entry through their ill-health is questioned, as is the limited range of health outcomes that screening can effectively assess, particularly at young ages (Lu, 2008). While immigrants can select for health and traits, migration is also a very stressful phase and this might actually increase risk for certain psychiatric or cardiovascular diseases (Spallek et al., 2011).

1.2.4. Phase III: The period after migration

Acculturation

Post-migration, immigrants are exposed to new risk factors in smoking, diet and a sedentary lifestyle which cause chronic diseases (Spallek et al., 2011). As immigrants acculturate and gradually adopt the unhealthier behaviours (Abraído-Lanza et al., 2005) often associated with a western society (Beiser, 2005) (as in the second phase of the healthy migrant effect) they begin to amass risk for chronic diseases at a similar rate to the host population. The cultural buffer developed pre-migration disappears (Jasso et al., 2004). Franzini et al. (2001) posit that low immigrant mortality will only persist if migrants remain culturally distinct from the host population. In a large-scale review of U.S. literature, Lara et al. (2005) find that in substance abuse and diet, acculturation has a mostly negative effect on health. In other areas, such as health care, acculturation can have a more positive effect. Descendants can inherit protective cultural beliefs and behaviours (Spallek et al., 2011). However, if immigrant relatives are well acculturated into the host society, they may not pass the culture-specific (and possibly health-preserving) behaviours down to their descendants (Tarnutzer and Bopp, 2012). Consequently, descendants' beliefs and behaviours will better reflect the host society (Eitle et al., 2009). Acculturation can be crucial for inter-generational changes in health behaviour (Spallek et al., 2011).

Socioeconomic status

After migration, immigrants can experience adverse socioeconomic conditions (Bhopal, 2002). Time spent in these conditions increases disease risk by a process of accumulation (Spallek et al., 2011). A socioeconomic mortality paradox, where migrants have low mortality relative to the host population despite poor socioeconomic status has been found among Hispanics and Mediterraneans (Khlat and Courbage, 1996; Abraído-Lanza et al., 2005). This phenomenon is paradoxical because differences in mortality outcomes by socioeconomic status are pervasive (Geyer and Peter, 2000) and the prevalence of health-damaging behaviours is more prevalent in disadvantaged socioeconomic groups (Emmons, 2000). Spallek et al. (2011) argue that this finding is explained by the rapid nature of the health transition which precedes the gradual, cumulative health-degrading effect of poor socioeconomic status. An additional, psychosocial interpretation in the *migrant hope effect* posits that immigrant's hopes for improvement and different frames of reference for progress in co-ethnics and their peers in the country of origin (relative to non-migrants in the host country who are their own frame of reference) render poor socioeconomic conditions tolerable (Anson, 2004; Heath and Li, 2008). This more sanguine outlook may reduce the production of negative emotions that can translate into poor health via psycho-neuro-endocrine mechanisms and certain stress-induced behaviours in smoking and reduce effects of an adverse socioeconomic status on mortality (Marmot, 1989; Lynch et al., 2000).

The socioeconomic status of immigrants determines the socioeconomic status of descendants during their childhood and this can have an enduring influence in their later life (Spallek et al., 2011). If descendants experience childhood in the poverty, social upheaval and poor living conditions (Hjern and Allbeck, 2002) that immigrants can experience shortly after their arrival (Bhopal, 2002), then mortality among descendants may better reflect pathologies associated with poverty (Gans, 1992) in the greater risk for some cardiovascular and respiratory diseases (Galobardes et al., 2004). The descendants of immigrants may also have a different frame of reference in the White England and Wales-born population (Heath and Li, 2008). So, while immigrants may feel they are doing as well as co-ethnics and better than peers in the country of origin, descendants often feel they are doing less well than the majority population (Heath and Li, 2008). Increased expectations and greater frustration in the face of perceived limited opportunities relative to the majority population (Gans, 1992) may, if the migrant hope effect is correct, exacerbate the psychosocial impacts on descendants of their adverse socioeconomic status.

Discrimination

Immigrants can experience discrimination in the host society which has been shown to affect health (Nazroo, 2003). Both U.S. and UK studies have reported links between instances of racial harassment, perceptions of racial discrimination and a wide array of health outcomes, including self-related health, hypertension, depression, psychosis and respiratory illnesses (James, 1987; Krieger et al., 1993, 1996 & 2000). Descendants of immigrants can represent an age-specific vulnerability to discrimination (Hjern and Allbeck, 2002) because they are prone to experience of racism and discrimination as children (Connolly, 1998; Verkuyten and Thijs, 2002). However, if discrimination factors into ethnic segregation, some posit that socio-cultural advantages conferred on immigrants by living in high-density ethnic areas can outweigh the disadvantages of the high poverty of those neighbourhoods (Eschbach et al., 2004). This *Barrio advantage* also strongly relates to the socioeconomic mortality paradox, and has been found among Hispanic migrants in the U.S. (Eschbach et al., 2004; Aranda et al., 2011; Richter et al., 2015).

Healthcare

After arrival in the host country, immigrants benefit from access to health care for infectious diseases (Spallek et al., 2011), though ethnic minorities can face health care barriers including a lack of information on access, language difficulties which limits the ability of health care providers to diagnose and treat and cultural differences in attitudes to healthcare (Szczepura, 2005; Jayaweera, 2014). In the UK, a recent study reports differences between the negative experiences of South Asian and Chinese patients relative to White (the experience of Black patients was similar to the White UK-born) (Lyratzopoulos et al., 2012). Lyratzopoulos et al. (2012) posit that patients received similar standards of care but had very different experiences based on language proficiency. This may explain documented ethnic-specific experiences in that immigrants of Black Caribbean descent, unlike South Asians or Chinese, share English as the first language with the White UK-born (Connolly and White, 2006). Equally, given that the language fluency of descendants is often better than it is for many immigrants (Heath et al., 2008) there may be an inter-generational effect in perceptions of access to, and quality of, healthcare. Another study finds at least equal use of primary health care services (except for Chinese) and that outcomes of care are as good for ethnic minorities as for UK-born (Nazroo et al., 2009). Nazroo (2014) posits that healthcare does not contribute to ethnic inequalities in health.

Return migration

After a period of time in the host country some migrants choose to return home. The *salmon bias effect* posits that migrants return home to die at old ages through a strong desire to die in the place of birth (Turra and Elo, 2008). The *unhealthy re-migration effect* posits that migrants can return to the country of origin at younger ages based on poor general health (Razum et al, 1998). Salmon bias leads to an undercount of deaths in the host country (because the deaths are not recorded in host country statistics) (Turra and Elo, 2008). The unhealthy remigration effect constitutes an out-selection of the “worst of the best”, where the returnees have the worst health of the migrants who moved from the country of origin. The returns accentuate the good health status of the remaining migrant stock (Wallace and Kulu, 2014). However, researchers question the ability of ill migrants to undertake and survive a trip home (Khlat and Darmon, 2003), especially given the quality and accessibility of health care in the host country (Razum et al., 1998) and that family have often settled in the host country (which may negate the desire to return) (Arnold et al., 2010). Some studies also find that poor health decreases the propensity to remigrate (Wallace and Kulu, 2014; Norredam, 2014). Remigrants already have information on the country of origin, have moved once before and may move again (Constant and Massey, 2003).

Registration uncertainty

Linked to return migration is the idea of *data artefact*, which proposes that, instead of factors such as the healthy migrant effect, cultural factors or the immigrant health transition, low immigrant mortality is artificial and the culmination of a number of possible error sources. An immigrant population is a changeable population, which is difficult to capture in data sources, as individuals both enter and leave the host country over various periods of time (Anson, 2004). Possible sources of error range from age misreporting, to misclassification of country of birth or ethnicity on death certificates and registration uncertainty which relate to migrant moves between origin and host countries (Deboosere and Gadeyne, 2005). It is the latter which most seriously questions the reliability of mortality rates. If departures from the host country and deaths which occur shortly after exit are not recorded, these errors conspire to overestimate the population at risk (inflating the denominator) (Kibele et al., 2008). People become "statistically immortal" as they continue to age in host country databases, even after death (Abraído-Lanza et al., 1999). This may lead to conclusions of low migrant mortality when it is actually a data artefact.

In sum, immigrant mortality is influenced by factors which operate at different phases of the lifecourse (Spallek et al., 2011). Some factors, such as genetics, persist unchanged across the lifecourse. Others factors, such as socioeconomic status also influence mortality across the lifecourse, but immigrants are exposed to two different sets of conditions in the origin and host countries. Some factors, such as selection, act at migration while others, such as acculturation, influence mortality only after migration. Descendants differ from immigrants in that, as figure 1.1 shows, they are only exposed to one set of conditions in the host country (which is really their country of origin). Further, the migration process does not directly influence mortality among descendants. However, their descendants are indirectly exposed to the culture-specific beliefs and behaviours of the country of origin through their immigrant relatives (depending on how acculturated immigrant relatives are). When studying descendants' mortality, studies should consider the influence of both immigrant exposures i.e. that certain culture-specific beliefs and health behaviours may be passed from immigrants to their descendants (Spallek et al., 2011) and the influence of context-specific factors in the host country such as geography, interaction with the local education system and labour market and discrimination (Platt et al., 2005).

1.3. A brief history of migration to England and Wales, 1951-2011

Before World War II the main migrant populations in Britain were the Irish, and Jewish from Eastern Europe (Hannemann and Kulu, 2015). The migration of the Irish-born stretched back to the 1840s famines in Ireland and was associated with rapid industrialisation in Great Britain throughout the 19th century (Smith, 2013). Between 1946 and 1949, a net inflow of 350,000 individuals from Ireland provided manual labour for industry and construction; many workers brought their families and settled in Britain (Castles et al., 2014). Jewish immigrants, mostly from Russia, arrived as refugees in the late 19th and early 20th century (Castles et al., 2014). World War II also brought more refugees to Britain in the Polish-born (who fled Poland in 1939 and were reluctant to return after 1945), German-born political refugees, and Russian-born from non-Russian ethnic groups who did not wish to return to the post-war Soviet Union (Smith, 2013). The 1951 census showed that the largest immigrant population was those from Ireland (who accounted for more than a quarter of all foreign-born people), followed by people from Poland, India, Germany and Russia (Smith, 2013). The large numbers of Indian migrants were children of British service personnel born in India before Independence in 1947 (Smith, 2013).

After World War II, Britain, as with many other Western and Northern European countries, became a destination for post-war labour migration (Castles et al., 2014; Hannemann and Kulu, 2015). Labour migration from the *New Commonwealth* (the former colonies in the Caribbean, Indian Subcontinent and Africa) started after 1945 (Castles et al., 2014). The first to arrive were workers from the Caribbean, especially Jamaica, on the Empire Windrush (would later come to symbolise the Windrush Era (1948-1962) of immigration from former colonies). Some immigrants came to work for London Transport (Castles et al., 2014) and the National Health Service (Peach, 1996), but many also migrated spontaneously in response to demand (Castles and et al., 2014). The British economy suffered from labour shortages due to economic growth and small pre-war cohorts entering the labour market after World War II (Peach, 1996). Between 1951 and 1961, Jamaican entry numbers rose from 6,000 to 100,000, reaching a peak of 171,000 in 1971 (Smith, 2013). The 1961 census showed that the largest migrant population was from Ireland, followed by immigrants from India, Germany, Poland and Jamaica (Smith, 2013).

This arrival of Caribbean labour migrants was swiftly followed by the arrival of Indians and Pakistanis, whose migration to Britain peaked in the late 1960s and early 1970s (Hannemann and Kulu, 2015). Many took jobs in the textile industry (Peach 1996). Indians accounted for a large proportion of the total foreign-born population in all censuses after World War II, but their largest increase was between 1961 and 1971 when their numbers almost doubled. The Pakistani population also quadrupled during the 1960s; this increase related to both the war with India in 1965 and labour migration to Britain (Smith, 2013). The number of immigrants born in Kenya also increased from 1961. Many were East African Asians (the descendants of immigrants from the Indian subcontinent) who had settled in East Africa during British colonial administration and experienced discrimination in Kenya (Smith, 2013). The 1971 census showed that Jamaicans had become the third largest immigrant group in Britain (after Irish and Indian) and Pakistanis the fifth (after German-born) (Smith, 2013). However, at this time, the Pakistani group also included Bangladeshis (pre-Bangladeshi war of independence) (Smith, 2013).

After the Bangladeshi war of independence in 1971 and subsequent military coup in 1975, the number of Bangladeshis living in England and Wales increased. Their immigration was also influenced by the associated poverty and instability in the country in the 1980s and earlier. The influx of immigrants from Bangladesh would continue to rise before reaching a peak in the late 1990s and early 2000s (Smith, 2013).The 1981, 1991 and 2001 censuses showed that Ireland remained the largest immigrant group in Britain, followed by India, Pakistan, and Germany (Smith, 2013). After 1962, the entry of New Commonwealth workers declined due to the introduction of restrictions through the *Commonwealth Immigration Act* and further through economic stagnation in Britain. However, family reunification continued until it too became restricted by the *Immigration Act* after 1971 (Castles et al., 2014). Even so, by 1981, the population of Commonwealth immigrants living in Britain stood at 1.5 million (Castles et al., 2014). In the 1980s, given the stricter controls placed on entries, the main arrivals to England and Wales were largely Americans moving to work in bank and service industries, Australians, New Zealanders and South Africans taking advantage of family ties, and highly-skilled arrivals from South Asia, particularly India, who were moving to work in medical professions (Smith, 2013).

The 1990s saw a period of arrivals from countries experiencing conflict. Civil and national wars led to the arrival of immigrants from Kosovo, Afghanistan, Somalia, Sri Lanka, Rwanda and Angola (Smith, 2013). The break-up of former-Yugoslavia after 1992 was the source of a number of Balkan conflicts and resulted in the peak arrival of immigrants from Bosnia, Croatia, Serbia and Montenegro (Smith, 2013). Political unrest also led to the arrival of South Africans (whose numbers doubled between 1991 and 2001), Zimbabweans and Ghanaians (Smith, 2013). From 2000 onwards, the largest increase has been for Polish-born immigrants, with a near ten-fold increase as a result of Poland joining the EU. Similarly, following their accession to the EU, Britain has seen the arrival of immigrants from other Eastern European countries, including Hungary, Lithuania, Slovakia, Romania and Bulgaria (Castles et al., 2014). The number of Chinese living in England and Wales more than doubled between 1991 and 2001 and tripled by 2011, reflecting the high level of education migration (Smith, 2013). For the first time since World War II, Ireland was no longer the major immigrant population in England and Wales. India was the biggest, followed by Poland, Pakistan, Ireland and Germany (Smith, 2013).

The ethnic minority population has grown rapidly since the 1950s when the population was less than 100,000 and largely confined to dockland areas in cities such as London, Liverpool, Cardiff and Bristol (Lupton and Power, 2004). Black people of Caribbean origin were the earliest arrivals in the post-war period of migration, with immigrants settling in London and other major cities (Lupton and Power, 2004). People with Pakistani and Indian backgrounds arrived in large numbers in the 1960s and Bangladeshis from the 1980s (Peach, 1996). Some settled in large cities, but Pakistanis and Bangladeshis settled in the smaller textiles towns in Lancashire and Yorkshire where there was demand for 24-hour labour (Lupton and Power, 2004). In the 1980s, Chinese immigrants migrated for, and stayed after, their higher education (Dustmann et al., 2011). The geographical distribution of ethnic groups continues to reflect the historic settlement pattern of immigrants in the UK and London remains the first place of settlement for immigrants. In 2011 ethnic minority groups comprised over half of the London population (Jivraj and Simpson, 2012). However, recent evidence shows residential mixing, particularly towards districts adjacent to the initial areas of settlement (Jivraj and Simpson, 2012). The Chinese are the most widely dispersed ethnic group (Stillwell and Duke-Williams, 2005).

Over time, the ethnic population has increased from 7% in 1991, to 13% in 2001 and 20% in 2011 (Bradford, 2012). The main ethnic groups in descending size order are Indian, Pakistani, Black African, Other Asian, Black Caribbean, Bangladeshi, Chinese and Black Other. The oldest group is the Black Caribbean (Bradford, 2012) and the fastest growing group is Black African, which doubled in size between 1991 and 2001, and again in 2011 (Jivraj and Simpson, 2012). The number of people reporting mixed ethnicity has also grown since 1991 (Bradford, 2012). In 2011, a sizeable per cent of individuals from Other Black (*68*), Black Caribbean (*60*), Pakistani (*56*), Bangladeshi, Indian (*43*), Black African (*33*) and Chinese and Other Asian (*25*) backgrounds were UK-born (calculations based on Nomis data). The performance of ethnic groups in the UK in terms of their employment, educational success and life chances has been mixed (Platt, 2005). Indian, Chinese and Black African have the highest educational attainment of all ethnic groups (Lymperopoulou and Parameshwaran, 2012). In the labour market ethnic inequalities persist (though Indian and Chinese men do have similar rates of economic activity to White) (Khapadia et al., 2012). All ethnic groups are more likely to live in deprived areas than White, with Pakistanis and Bangladeshis three times as likely (Jivraj and Khan, 2013). Ethnic groups with more skilled and educated origins (e.g. Indian, Chinese) have been found to reassert their backgrounds over generations after initial downward migration, but ethnic groups with less-skilled origins (e.g. Black Caribbean) have remained less-skilled (Platt et al., 2005).

1.4. Data

1.4.1. The Office for National Statistics Longitudinal Study (LS)

Each chapter in this thesis uses the Office for National Statistics Longitudinal Study (LS), a continuous multi-cohort study which links census and life event information for a nationally representative 1% sample of the population living in England and Wales. The original sample was selected from the 1971 Census and linked census and life event data on individuals born on one of four anonymous dates of birth. Information on these people has been updated at the censuses in 1981, 1991, 2001 and 2011 and, during this time, new members (as long as they were born one of the four anonymous dates) could enter into the LS either at the time of the next census or by registering with the National Health Service (NHS) between census years (Hattersley and Creeser, 1995). Information on life events has been added to the LS since 1971. Events include births and immigrations (entry events) and deaths and emigrations (exit events). Migration data are taken from NHS registration systems while data on births and deaths are taken from civil registration data. Data on over one million people has been collected over forty years and at each census and sociodemographic data on approximately 500,000 individuals is collected.

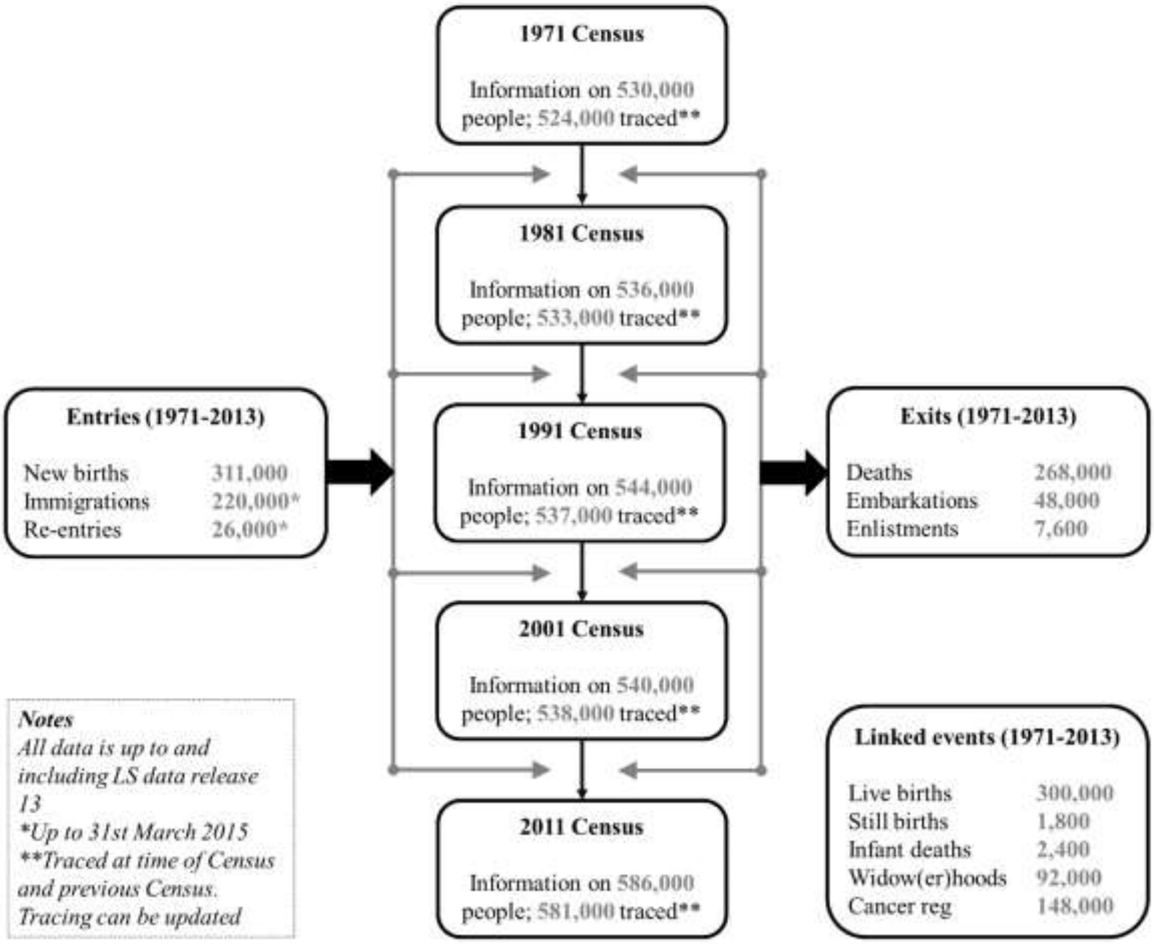

Figure 1.2. Structure of the Office for National Statistics Longitudinal Study.

Source: Office for National Statistics Longitudinal Study

With reference to fig 1.2, LS members are traced when their record is found in NHS registration systems. The systems enable records for LS sample members to be linked to various life events for individuals. It also facilitates matching of records collected at different points across time. LS members will be "untraced" if they have not been found, either because they have not been registered with a doctor, or inconsistent names or dates of birth have been used. Linkage of life event data through the NHS registration systems is unlikely for untraced LS members. While tracing rates differ across censuses, only 3.2%, 1.2%, 1.6% and 0.7% were untraced at the 1971, 1981, 1991 and 2001 censuses respectively (Blackwell et al., 2003). However, a number of factors can relate to LS members not being traced (being a young male, divorced, being an immigrant or belonging to an ethnic minority, living in London, being a student or being long-term unemployed or never having worked (ONS, 2015a)); not traced rates can vary across sub-groups.

The recording of births and deaths are very reliable in England and Wales (ONS, 2015b). Death certificates are a legal requirement and virtually all deaths in England and Wales are registered. However, some deaths can be missed if incomplete/inaccurate information is provided at registration resulting in an inability to match the record to the LS member. Delays can occur if an inquest is necessary or if someone died abroad (some deaths outside of England and Wales may not be captured in the LS). Deaths will also be missed if a body is not found (ONS, 2015b). Fig 1.3 shows mortality rates from the LS for periods 1971-80, 1981-90, 1991-2000 and 2001-2010 compared with the mortality rates in the UK taken from the Human Mortality Database (HMD; http://www.mortality.org/) for periods 1970-79, 1980-89, 1990-99 and 2000-2009. Mortality in the LS is largely representative, though there is a slight under-reporting of deaths. Across all ages, estimates for the LS lie within 90% CIs of the HMD and for most ages within 95%.

While the recording of births and death are very reliable in the LS, the quality of migration data in the LS is more difficult to measure. Ideally, it should contain 1% of international migration figures, but there is some doubt as to whether it does (Hattersley, 1999). Compared with the unadjusted International Passenger Survey (IPS) figures between 1987 and 1989, immigrants appeared to be over-represented (+43% difference to IPS) on the NHS registration systems and emigrants (-75% difference) under-represented (*see* Hattersley, 1999). The reasons for these differences in the registration of migration events are outlined below and the impact of this registration uncertainty is explicitly addressed in first chapter of the thesis. Nonetheless, the sample is said to be representative of the large migrant groups in England and Wales and cause-specific mortality patterns for those from the Indian subcontinent have been found to be similar to those observed in the national (100 per cent) cross-sectional data (Harding and Balajaran, 2002).

1.4.2. Entry into the LS

Entry events are when a birth is registered, an immigrant registers with the NHS, or a person completes a census form for the first time. In all instances individuals are living in England and Wales and born one of the four anonymous LS dates of birth. Updating the sample with new births is straightforward; all births in England and Wales require registration by law. The registrar sends a draft entry form to the ONS for statistical processing. NHS registration systems then receive notification of births from the ONS, detailing the baby's name, date of birth and NHS number, which is used to update the patient register. However, immigrants receive a number and enter onto the patient register only when they register with the NHS and state their intention to stay in England and Wales beyond three months. Immigrants are people who have given a previous address which is outside of England and Wales (including Scotland, Northern Ireland and Channel Islands) and cannot be linked to a current NHS number (ONS, 2015c).

For immigrants, there can be a delay in registration where an individual is healthy and does not feel the need to register with a doctor. Further, although the date of entry into the country is asked for on the doctor's application list, it is not cross-checked against other sources and could be inaccurate (Hattersley, 1999). Delays may also reflect a lack of engagement with the health services in the host country (Shuttleworth and Barr, 2011). While many may simply forget to register with the NHS, upon registration some may intentionally state earlier dates to help further claims for e.g. resident status and childcare benefits (Weitoft et al., 1999). A significant delay in the first-time registration could result in an incorrect entry date. Additionally, the completion of a census form could precede registration with an NHS doctor. The LS may also miss those who use private healthcare, short-term immigrants who emigrate after at least 1-year who have not registered with an NHS doctor during their stay, and European workers whose country has a reciprocal arrangement with the National Health Service (Hattersley, 1999).

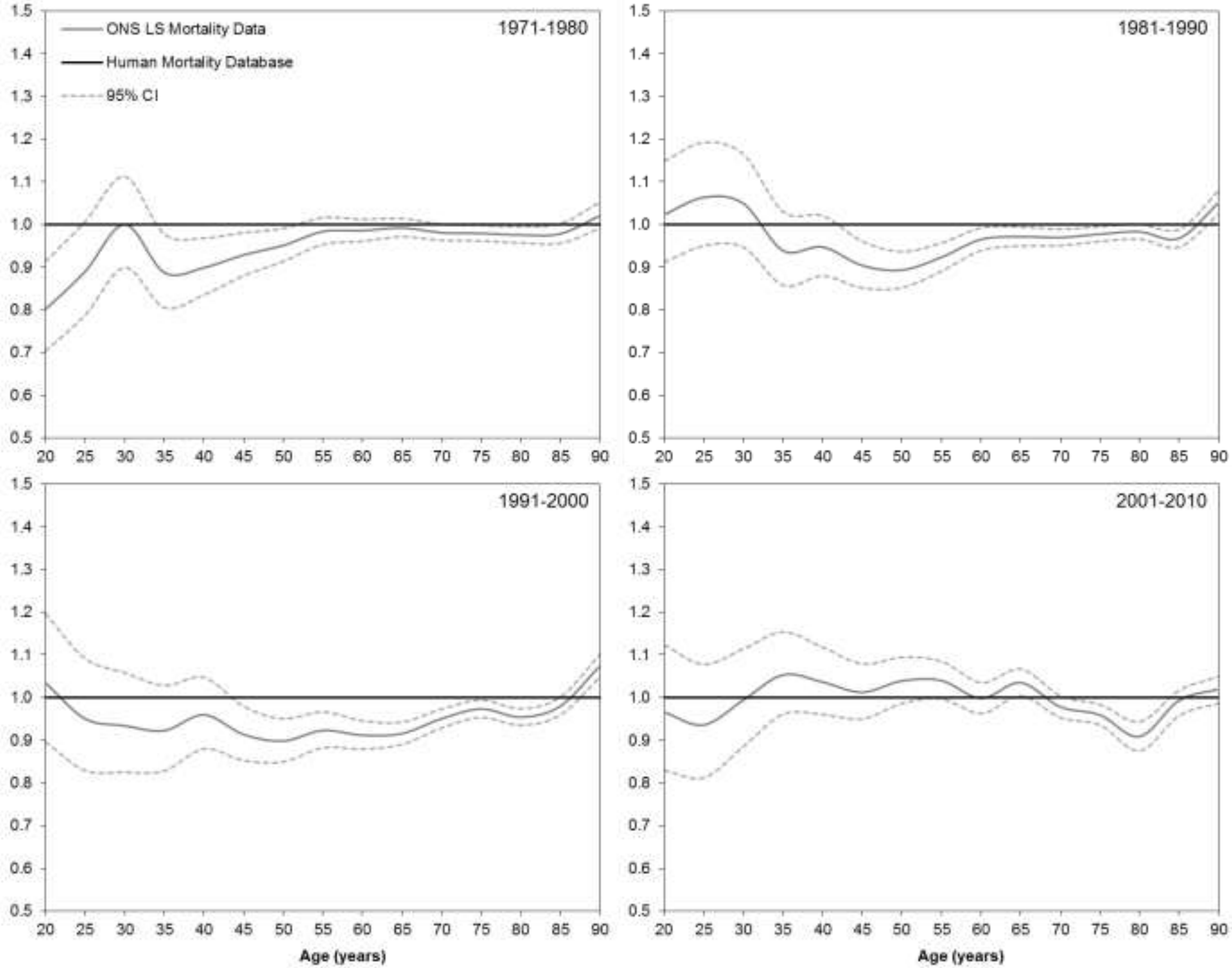

Figure 1.3. Comparison of age-specific mortality rates in the ONS LS with Human Mortality Database.

Source: author's calculations based on ONS LS and Human Mortality Database

1.4.3. Exit from the LS

Exit from the LS occurs through death (describe above) or emigration. For individuals leaving England and Wales, the NHS advises all patients to inform their doctor of their intention to de-register from the NHS. The ONS then receives an annual file from the NHS registration systems which includes records of the LS members who have embarked and de-registered from the National Health Service (ONS 2015c). The records of LS members are retained even if individual's die or emigrate. There can be problems with the non-registration of exits. If an LS member does not notify the NHS of their emigration they will have no exit date and become *lost to follow-up* (LTFU) (7; see figure 1.4) when no exit date is recorded and the LS member is not enumerated at subsequent censuses. However, because the LS includes more than one census point, it is possible to identify the decade of exit. If the individual is not present at the next census (having been enumerated at the last) and has not contributed events in the intercensal period, they can be exited from the study prior to the census where they have been found to be missing (Hattersley, 1999). By doing this, the LS member will contribute risk-time to the denominator only while they are known to be alive and likely still living in the country (Hattersley, 1999). Possible biases arising through censoring are directly addressed in chapter I.

Among LS sample members present at the 1991 census that were not recorded as having died or left before the 2001 census, 12.2% were not found. In 1991 this figure was 10.2% and in 1981 8.7%. For migrants who record entries between censuses, comparable figures for LTFU in 1981, 1991 and 2001 were 48%, 62% and 66% (Blackwell et al., 2003). Characteristics of LTFU include greater likelihood of being young and male, belonging to an ethnic minority and being an immigrant (Blackwell et al., 2003). LS members can also be LTFU through census under-enumeration (the person is still in England and Wales but was not counted at census) or non-linkage (a date of birth was mis-recorded or person identifiers are of poor quality and the person was not included in the LS extract) (Blackwell et al., 2003). However, in their study of attrition in the LS, Platt et al. (2005) cautiously suggest that, given the strength of ethnic group effects in their models, many LTFU up are likely to be unrecorded emigrations. Ultimately it is not possible to provide definitive answers as to how everyone is LTFU (Blackwell et al., 2003).

1.4.4. Temporary exit and re-entry events in the LS

Re-entries can occur when LS members who emigrate and de-register from the NHS later re-register with the NHS. Two types of LS member can be defined (Robards et al., 2011). The first, *consistent cases*, includes individuals who are continually resident and do not record exits or re-entries during their time in the LS (1, 2, 3, 4 and 5; see figure 1.4). Consistent cases also include non-continually resident cases, where LS members leave and return to England and Wales; these events are recorded and chronological i.e. a re-entry date is later than its partnered exit date (6 and 8). However, temporary exits and re-entries have the same potential for error as first time entries (people may not re-register with a doctor immediately on arrival back in the country) and exits (people may not inform their doctor of their intention to leave). As a result, *inconsistent cases* exist where there is at least one event date missing, or events are not chronological i.e. a re-entry date is earlier than its partnered entry date. Out of risk periods for those who have a chronological series of event dates are factored into the study design. For individuals who have just one missing date (<1%), an arbitrary value of 1-year earlier is imputed, contingent that any earlier dates precede the imputed date by at least 1-year (so as not to create any further inconsistency). Individuals who have more than one missing date and individuals who have an unchronological set of migration events (<0.5%) are excluded from analyses.

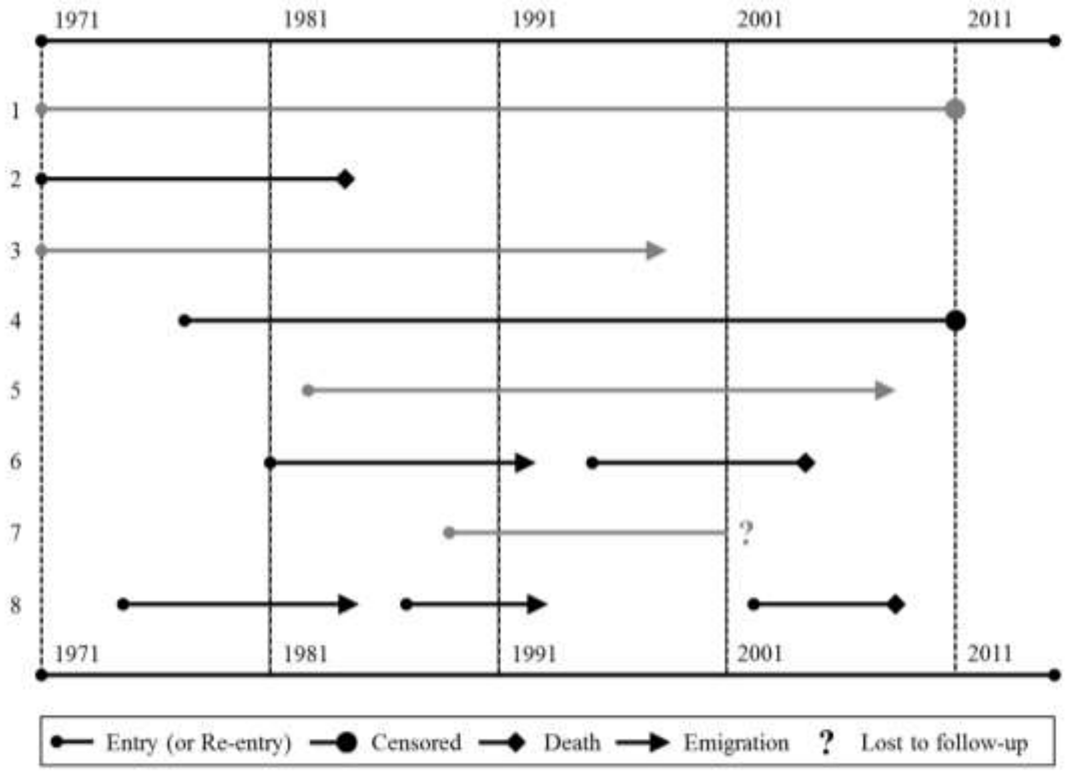

Figure 1.4. Example life courses of LS members.

1.5. Defining immigrants and their descendants

Immigrant status is defined using country of birth. Country of birth is a question asked at each census from 1971 to 2011 and is self-reported by those who complete the census form. While there is some variation in categories over time and the number of answers expands at each census, country of birth can be standardised across censuses. For each census, country of birth is categorised to: England and Wales, Scotland, Republic of Ireland, Northern Ireland, India, Pakistan, Bangladesh, Jamaica, Other Caribbean, East and South Africa, West and Central Africa, China, Other Asia, Western Europe, Eastern Europe and the Rest of the World. In relation to migration history in England and Wales (section 1.3), the analysis includes the main post-war Commonwealth immigrant populations (India, Pakistan, Bangladesh, and Jamaica) but groupings were created when the size of the sample did not permit the analysis of individual countries. Appendix A shows the countries available at each census, how the countries were categorised into the above groups and the top five sending countries for each group (for groups composed of more than one country). For people present at just one census, the country of birth reported at that census is used. For those present at multiple censuses, the modal country of birth is used. For example, an LS member who is present at the 1971, 1981 and 1991 censuses who selects e.g. India at at least two censuses is assigned India as their definitive country of birth.

This method assigned a country of birth to over 99% of the sample. Remaining people (6,200) were classed as tied e.g. an LS member present from 1971 to 2001 who specified Jamaica at the 1971 and 1981 censuses but England and Wales in 1991 and 2001 is tied. The number of ties could be reduced by investigating cases to see why people had tied and reassigning them based on certain rules. As a general rule, when ties resulted from a combination of England and Wales and a foreign country, the latter was assigned to maximise the number of immigrants available for analysis. If a country of birth was imputed in 2001 and the tie was a result of this imputed country and a country specified at another census (which was not imputed), the country reported by the LS member was assigned. Bangladesh only gained dependence in 1971 (Connolly and White, 2006). As a result, at the 1971 census it was part of a combined category with Pakistan. This led to ties between this category in 1971 and later selections of Pakistan or Bangladesh. Similarly, at the 1971 and 1981 censuses some LS members born in the Republic of Ireland or Northern Ireland only answered Ireland. This led to ties between this category and later selections of Republic of Ireland or Northern Ireland. In both of these cases, LS members were assigned their later answers, when people were able to, or chose to specify a more detailed answer.

The best way to define the descendants of immigrants is by combining country of birth with ethnicity. Ethnicity was first asked at census in England and Wales in 1991. Country of birth is aggregated to a binary (*0=born in England and Wales* and *1=born abroad*). Ethnic group is standardised to the 1991 census definition of ethnicity; although new categories have become available (particularly between the 1991 and 2001 censuses) at subsequent censuses, it is not possible to track back new ethnic categories offered by later censuses for individuals who have died in the intercensal period (who resultantly did not fill in a census form). The tick box categories originally offered at the 1991 census were White, Indian, Pakistani, Bangladeshi, Black Caribbean, Black African, Chinese, Black Other and Any Other Ethnic Group. A combination of written descriptions, together with multiple ticking of boxes on census forms led to the derivation of the mixed groups: Black and White and Asian and White (CeLSIUS, 2013).

The combination of country of birth and ethnic group facilitates the distinction of ethnic minorities who are born outside of England and Wales (and Scotland, Republic of Ireland and Northern Ireland) (*immigrants*), and those from ethnic minorities born in England and Wales (*descendants*). Ethnicity is a fluid and changeable concept (Bhopal, 1999) and unlike country of birth, is not a fixed characteristic during a person's life (Simpson et al., 2012). Consequently, for ties, the ethnic group selected by the LS member most recently is taken because newer categories may better identify with family background (Simpson et al., 2012). Ethnicity is an unstable concept with 2% of people changing their ethnicity between 1991 and 2001 and 4% between 2001 and 2011 in the UK (Simpson et al., 2012). The first seven groups listed in the above paragraph are stable enough for analysis over time (Simpson et al., 2012). There are also two other ways to define descendants of immigrants. The first, using parents' and LS member's country of birth in 1971 is limited to the 1971 sample and census definition of country of birth (parents' country of birth was only asked at the 1971 census). The second, taking new births and/or children under the age of 16-years (where household information could be used to identify descendants of immigrants) would have created a very young sample (maximum age 57-years in 2012) and it is unlikely that there would have been enough deaths for a robust analysis.

Table 1.1 shows the top ten non-UK countries of birth for the population in England and Wales for the censuses covered by the LS (1971, 1981, 1991, 2001 and 2011) using complete census data. Table 1.1 shows the size of the populations by country of birth and their change in rank over time (under the Pos column) (i.e. we can see that Pakistan was raised one position to third between 1971 and 1981). Table 1.2 also shows the top ten non-UK countries of birth for the population in England and Wales using the ONS LS 1% sample. The Pos column in Table 1.2 is different to Table 1.1 in that it shows the change in position of the country *relative to its position in Table 1.1*. The purpose of this is to compare, given that the LS is a 1% sample, the rank of the top ten non-UK countries of birth to full census data. In the LS (Table 1.2), as for the census data (Table 1.1), Ireland is the largest non-UK country of birth until 2011, when India becomes the largest. The same major non-UK countries consistently feature in the top ten and the order of countries remains similar, particularly for the top five countries at each census.

Table 1.1. Top ten non-UK countries of birth in England and Wales 1971-2011 from ONS Census data.

	1971			1981			1991			2001			2011		
	Country	Size	Pos	Country	Size	Pos	Country	Size	Pos	Country	Size	Pos	Country	Size	Pos
1	Ireland	676,000	=	Ireland	580,000	=	Ireland	570,000	=	Ireland	473,000	=	India	694,000	↑1
2	India	313,000	=	India	383,000	=	India	400,000	=	India	456,000	=	Poland	579,000	
3	Jamaica	171,000	=	Pakistan	182,000	↑1	Pakistan	225,000	=	Pakistan	308,000	=	Pakistan	482,000	=
4	Germany	148,000	=	Germany	170,000	=	Germany	202,000	=	Germany	244,000	=	Ireland	407,000	↓3
5	Pakistan*	136,000	=	Jamaica	164,000	↓2	Jamaica	142,000	=	Bangladesh	153,000	↑3	Germany	274,000	↓1
6	Poland	104,000	=	USA	106,000	↑2	USA	131,000	=	Jamaica	146,000	↓1	Bangladesh	212,000	↓1
7	Italy	103,000	=	Kenya	100,000	↑3	Kenya	111,000	=	USA	144,000	↓1	Nigeria	191,000	
8	USA	100,000	=	Italy	93,000	↓1	Bangladesh	104,000		South Africa	132,000		South Africa	191,000	=
9	Cyprus	72,000	=	Poland	88,000	↓3	Italy	87,000	↓1	Kenya	127,000	↓2	USA	177,000	↓2
10	Kenya	58,000	=	Cyprus	83,000	↓1	Cyprus	77,000	=	Italy	102,000	↓1	Jamaica	160,000	↓4

<u>Note:</u> Position is relative to position at previous census

*For both tables Pakistan and Bangladesh are combined in 1971

Table 1.2. Top ten non-UK countries of birth in England and Wales 1971-2011 from ONS LS data.

	1971			1981			1991			2001			2011		
	Country	Size	Pos	Country	Size	Pos	Country	Size	Pos	Country	Size	Pos	Country	Size	Pos
1	Ireland	8,116	=	Ireland	9,093	=	Ireland	8,722	=	Ireland	7,162	=	India	11,305	=
2	India	4,999	=	India	6,634	=	India	6,917	=	India	7,002	=	Pakistan	7,541	↑1
3	Pakistan*	2,582	↑2	Pakistan	3,452	=	Pakistan	3,963	=	Pakistan	4,603	=	Ireland	6,351	↑1
4	Jamaica	2,127	↓1	Jamaica	2,022	↑1	Germany	2,158	=	Germany	2,376	=	Poland	5,797	↓2
5	Poland	1,828	↑1	Germany	1,837	↓1	Bangladesh	1,969	↑3	Bangladesh	2,276	=	Bangladesh	3,889	↑1
6	Germany	1,569	↓2	Poland	1,465	↑3	Jamaica	1,697	↓1	Jamaica	1,446	=	Germany	2,692	↓1
7	Cyprus	1,242	↑2	Cyprus	1,296	↑3	USA	1,435	↓1	U.S.A	1,416	=	Nigera	2,077	=
8	Italy	1,153	↓1	Kenya	1,257	↓1	Kenya	1,363	↓1	Kenya	1,382	↑1	USA	1,854	↑1
9	USSR	811		USA	1,164	↓3	Cyprus	1,117	↑1	South Africa	1,267	↓1	China	1,829	
10	USA	784	↓2	Italy	1,016	↓2	Poland	1,095		Italy	1,006	=	South Africa	1,810	↓2

<u>Note:</u> Position of countries is relative their position at the same census in Table 1.1

Source: author's calculations based on ONS LS

1.6. Methods

1.6.1. Statistical methods

The thesis uses survival analysis, a set of methods where the outcome variable is time to the occurrence of an event of interest (Cleves et al., 2010), in this case, death. Survival models estimate the *hazard rate* ***h(t)***, which characterises the probability distribution of ***t*** (in this study ***t*** is age, as the age at entry and exit/censoring are specified in the data setup) or the conditional probability of event occurrence per unit time (Mills, 2011). The hazard rate can also be defined as the propensity to change from origin state ***j*** (alive) to destination state ***k*** (dead) at ***t*** (formula below).

$$h(t) = \lim_{t' \to t} \frac{\Pr(t \leq T \ < t \,|\, T \ \geq t)}{t' - t}$$

Subjects are followed over a specified time or *risk period*. The occurrence of the event of interest during the *risk period* is known as a *failure*. The duration or time that it takes before an event occurs (if it occurs) is the *survival time* (Mills, 2011) and if an individual reaches the end of the *risk period* and the event has not occurred, they have *survived* and become *right-censored* (the event has not occurred before the end of observation). If someone returns to their country of origin before the end of the study, they too become *right-censored* (the event has not occurred before the individual emigrated, from which point it is no longer possible to observe them) (Cleves et al., 2010). Survival analysis is well-suited for this research because it allows users to describe and explain the development of the process at every point in time (providing valuable information on the length of time leading up to death), it can deal with attrition and those who emigrate from England and Wales before the end of the risk period (of which there are many cases in the LS), and allows users to include time-varying variables in analyses.

In chapters I and IV a parametric survival model is used to study all-cause mortality among immigrants, their descendants and the England and Wales-born host population. Parametric models assume that the underlying distribution of event times follow a specific shape. While some prefer to use a Cox proportional hazards model because it makes fewer assumptions (in that it assumes an effect of covariates on failure but does not specify an underlying probability distribution), if we are confident that ***h(t)*** closely follows a specific probability distribution, a parametric model can provide more precise estimates. In the case of mortality, a Gompertz distribution (which suggests an exponential increase in mortality over age) has been shown to provide a very close fit to adult mortality in western countries. The basic model in chapters I and IV is:

$$\mu_i(t) = \mu_0(t) \times \exp\left\{\sum_j \beta_j x_{ij}(t)\right\}$$

where $\mu_i(t)$ denotes the hazard (force) of mortality for individual i at age t and $\mu_0(t)$ denotes the baseline hazard i.e. mortality risk by age which is assumed to follow a Gompertz distribution; individuals are under the risk at entry (from enumeration at census or immigration during the intercensal period) and are followed until death, emigration or right-censoring. $x_{ij}(t)$ represents values of a variable measuring sociodemographic characteristics; β_j is a parameter estimate for $x_{ij}(t)$.

In Chapter III, to study cause-specific mortality among immigrants and non-migrants living in England and Wales by specific cause of death, a cause-specific proportional hazards model is defined:

$$\ln \mu_k(t) = \ln \mu_{k,0}(t) + \sum_l \beta_{kl} x_l(t) + \gamma_k z,$$

where $\mu_k(t)$ denotes the hazard of mortality at age t and $\mu_{k,0}(t)$ denotes the baseline hazard, i.e. mortality risk from cause k by age, which we assume to follow a Gompertz distribution; $x(t)$ represents the value of variables measuring sociodemographic characteristics; β_k is a parameter estimate for $x(t)$, with l variables; γ_k denotes the effect of variable z, migrant status, on mortality from cause k. Causes of death are analysed using “extended” data. Setup is explained in chapter III.

Chapter II differs from I, III and IV in that discrete-time (not continuous) survival analysis is used. This is because in the above chapters, the LS has information on the exact date of death for those who die. However for remigration, for 90% of the events only the decade of exit is known. Discrete-time methods are appropriate when we have imprecise measurements and only know the event occurred in a particular interval. A competing-risk discrete-time survival model (which is also a logistic regression model) is used to in order to study remigration among migrants:

$$\ln \frac{p(Y_{it} = k)}{p(Y_{it} = K)} = \alpha_t^k + \sum_j \beta_j^k x_{ijt}$$

where $\boldsymbol{p(Y_{it}=k)}$ is the probability for person $\boldsymbol{i}$ of moving **(*k*=1)** or dying **(*k*=2)** during the period of $\boldsymbol{t}$ (given that s/he has not experienced one of the two events); $\boldsymbol{K}$**=0** and is a censored episode; $\boldsymbol{\alpha_t}$ is a set of constants to represent the time-dependency of the probability $\boldsymbol{x_{ijt}}$ is the value for person $\boldsymbol{i}$ of a covariate which may be time-varying, $\boldsymbol{\beta_j}$ is the parameter describing the effect of covariates. The models are described in more detail in the statistical methods section of each chapter.

1.6.2. Covariates

All models in each chapter adjust for basic demographic covariates age, sex, and time period. The outcome variable (event of interest) and additional socioeconomic covariates adjusted for are shown in Table 1.3 and the categorisation of the socioeconomic variables is shown in Table 1.4.

Table 1.3. Dependent and independent variables in each chapter.

Variables	Chapters			
	I	II	III	IV
Dependent variable(s)	*All-cause mortality*	*Remigration* *All-cause mortality*	*Cause-specific mortality*	*All-cause mortality*
Independent variable(s)	Age Sex Period Country of birth Education level Occupation type	Age (5-year groups) Sex Period Country of birth Long-term illness Education level Occupation type Marital status Area of residence Length of residence	Age Sex Period Country of birth Education level Occupation type Marital status Area of residence	Age Sex Period Ethnicity by country of birth Education level Occupation type Housing tenure Marital status Area of residence

All analyses adjust for age because age is the single most important determinant of mortality risk. Period is controlled for to account for improvements in mortality over time. Additionally, given that it is not possible to directly control for length of residence of those who enter the LS in 1971, controlling for period in analyses helps to capture cohort and specific time effects. All analyses adjust for gender because of pervasive sex differences in mortality; women live longer than men (Gjonça et al., 1999). Gender differences may also exist in migration. If men move for work and women largely move for family reunification, selection effects may be stronger among men (Boulogne et al., 2012). Socioeconomic variables occupation type, education level and housing tenure are adjusted because differences in health (and thus mortality) outcomes by socioeconomic position are persistent (Marmot, 1987 & 1989; Elo and Preston, 1996; Geyer and Peter, 2000). Moreover, it is generally accepted that prevalence of unhealthier behaviours is higher in low socioeconomic strata (Emmons, 2000). Marital status is adjusted for because a protective marital effect on mortality has been repeatedly observed across countries (Hu and Goldman, 1990). Adjusting for area of residence type accounts for the fact that London is still the initial area of settlement for immigrants after arrival (Jivraj and Simpson, 2012). For chapter II, which studies remigration from England and Wales, duration of residence is controlled (and can be adjusted for because the study only covers the LS period 1991 to 2011) because most remigrations occur within the first 5-years after arrival (Dustmann and Weiss, 2007).

1.7. Chapter summary

Chapter I examines all-cause mortality among immigrants in England and Wales between 1971 and 2001. While past research has found low mortality among migrants relative to non-migrant host populations, the actuality of the migrant mortality advantage remains contested because studies seldom account for registration uncertainty. A migrant population is a changeable one as people come and go over variable time periods and their moves may not always be reported. Even if they are, the dates may be incorrect. These errors in the reporting of entry and exit dates can cause mortality underestimation, producing artificially low rates. As a register-based study, the LS is prone to uncertainty in the registration of migration events. The aim of chapter I is '*to assess whether the mortality differences between immigrants and the non-migrant host population in England and Wales are a data artefact*'. Survival analysis is used to fit sensitivity models, testing different entry and exit dates to assess the impact that registration uncertainty has on migrant mortality rates. A "best" scenario is adopted to fit a model which tests whether remaining differences in mortality can be explained by socioeconomic characteristics. Finally, age interactions are fitted to determine whether the migrant mortality advantage persists over time/age.

Chapter II studies health-related remigration among migrants in England and Wales between 1991 and 2011. As with registration uncertainty, remigrations (especially if they are driven by poor health) can introduce bias into migrant mortality rates, causing an undercount of deaths in the numerator of mortality calculations. Migrants may choose to return home to die at older ages, motivated by a cultural desire to die in their place of birth, or at younger ages based on poor general health. The aim of chapter II is to '*to investigate whether immigrants are more* *likely to remigrate from England and Wales if they are in poor health*'. Competing-risk, discrete-time survival models are used. First, remigrations are modelled to see which groups have the highest likelihood of remigration. Second, remigrations are modelled contingent on limiting long-term illness to determine whether migrants from specific countries of birth are more likely to remigrate in poor health relative to migrants from the same country who choose to stay in England and Wales. Socioeconomic characteristics are adjusted for to see whether patterns persist. Finally, remigrations are modelled for two different age groups (20-64 years and 65+) to observe whether health-related remigrations are limited to younger ages or older ages.

Chapter III examines cause-specific mortality among migrants in England and Wales between 1971 and 2012. Previous research is extended by studying the major causes of death to improve our understanding of the factors which produce a migrant mortality advantage. While analysis of all-cause mortality (in chapter I and previous studies) is valuable to demonstrate a migrant mortality advantage among immigrants relative to the host population, it can mask substantial variation in mortality from specific causes of death. Thus the aim of chapter III is '*to determine if low all-cause mortality is driven by low mortality, or coexists with high mortality, from specific causes of death*'. Competing-risks survival models are implemented using "extended" data. By modelling the causes of death simultaneously, the analysis will provide mortality rates from specific causes of death among migrants relative to the England and Wales-born *and* show how important each cause is to overall mortality among the specific migrant groups. Models adjust for socioeconomic characteristics. Finally, age interactions are fitted for cardiovascular diseases and cancer to determine if mortality from chronic diseases exert a growing influence over time.

Chapter IV examines mortality among descendants of immigrants from 1991 to 2012. Research into the descendants of immigrants is limited because many have not yet reached ages of high mortality. However, the addition of census and migration event data to the Office for National Statistics Longitudinal Study (LS) to April 2011 and mortality data to December 2012 provides the opportunity to study the descendants of immigrants over a longer time span using a larger and, importantly, older sample compared to the other existing study of mortality among ethnic minorities born in England and Wales (Scott and Timaeus, 2013). The aim of chapter IV is to '*determine if low mortality among immigrants persists, converges to host population levels or reverses among descendants*'. Survival analysis is used to study mortality among migrants and the descendants of migrants relative to the White England and Wales-born population. Initially, mortality among migrants, their descendants and the non-migrant host population (as broader groups) is modelled. These groups are then classified by ethnicity into sub-groups to determine if the mortality patterns observed for these broad groups persist, or vary by ethnic minority group.

1.8. Contributions

Chapter I: Matthew Wallace was the lead author for this chapter which was co-authored by Hill Kulu. Wallace and Kulu both conceptualized and designed the study. Wallace planned the study, conducted data setup and analyses and wrote the chapter. Kulu contributed to revisions of the manuscript. **Chapter II:** Wallace was the sole author on this chapter. **Chapter III:** Wallace was the lead author for this chapter which was co-authored by Kulu. Wallace and Kulu both conceptualized and designed the study. Wallace planned the study, conducted data setup and analyses and wrote the chapter. Kulu contributed to revisions of the manuscript. **Chapter IV:** Wallace was the lead author for this chapter which was co-authored by Kulu. Wallace and Kulu both conceptualized and designed the study. Wallace planned the study, conducted data setup and analyses and wrote the chapter. Kulu contributed to revisions of the manuscript. After initial drafts of each of these four analysis chapters, Paul Williamson and Gemma Catney have both provided valuable feedback which ensured the continuing growth and development of the thesis.

Table 1.4. Categorisation of socioeconomic covariates.

Covariate	Categories	Coding
Area of residence type *(1971 - 2011)*	London	*London* *Outer London*
	Metropolitan	*Greater Manchester* *Merseyside* *South Yorkshire* *Tyne and Wear* *West Midlands* *West Yorkshire*
	Non-Metropolitan	*All other counties and Wales*
Education Level *(1971-2011)*	Degree level +	*Higher university degree* *Other degrees and equivalent*
	> A-level	*Other qual higher than A-level*
	< A-level	*A-level and equivalent* *GCSEs/O-levels* *No qualifications stated*
Housing Tenure *(1971 - 2011)*	Owned	*Owns with a mortgage or loan* *Owns outright* *Shared ownership*
	Social Rented	*Local authority/council* *Other social rented*
	Private Rented	*Private landlord (un)furnished* *Friend/relative/household member* *With a job, shop, farm or other business* *Housing association/charitable trust* *Lives rent free*
Marital Status *(1971-2011)*	Single	*Single*
	Married	*Married/Civil Partnership* *Re-married*
	Divorced	*Divorced* *Separated*
	Widowed	*Widowed*
Occupation type *(1971-2011)*	Professional/Managerial	*I Professional* *II Intermediate*
	Skilled	*IIIN Skilled Non-manual* *IIIM Skilled Manual* *IV Partly-skilled* *Armed Forces*
	Unskilled	*V Unskilled*
	Inadequately described	*Student or Child* *Other inactive* *Retired/permanently sick*

Source: Office for National Statistics Longitudinal Study

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Chapter I

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Low immigrant mortality in England and Wales: A data artefact?

Previous research observes low mortality among immigrants relative to host populations in western countries. This migrant mortality advantage is often attributed to selection processes in migration and cultural factors such as health behaviours. Little research has examined the role of data quality, especially the registration of moves. Registration uncertainty relating to moves between the origin and host countries can mismatch deaths and risk populations, leading to denominator bias and an underestimation of migrant mortality (a data artefact). The paper investigates mortality among immigrants in England and Wales from 1971 to 2001 using the Office for National Statistics Longitudinal Study (LS), a 1% sample of the population of England and Wales. We apply parametric survival models to study the mortality of 450,000 individuals. We conduct sensitivity analysis to assess the impact of entry and exit uncertainty on immigrant mortality rates. The analysis shows that most immigrants have lower mortality than the England and Wales-born. Differences largely persist when models are adjusted for registration uncertainty and become pronounced once we have adjusted for socioeconomic characteristics. This study supports low immigrant mortality and shows that it is not a data artefact.[1]

[1] Chapter I is based upon the research paper of the same name published in *Social Science & Medicine 120* (2014) 100-109.

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2.1. Introduction

Low mortality rates among immigrants compared to the host population in western countries has been found, among others, in New Zealand (Hajat et al., 2010), the U.S. (Abraído-Lanza et al., 1999; Palloni and Arias, 2004), Canada (McDonald and Kennedy, 2004), Germany (Razum et al., 1998), Belgium (Anson, 2004) and France (Khlat and Courbage, 1996). However, findings can be heterogeneous because mortality rates and risks can vary according to the country of birth, ethnicity and socioeconomic status (Norredam et al., 2014). Some Scandinavian studies, for example, have reported high immigrant mortality (Sundquist and Johansson, 1997; Sundquist and Li, 2006). This questions the actuality of the migrant mortality advantage. Registration uncertainty relating to moves between the origin and host countries can mismatch deaths and risk populations, causing numerator/denominator mismatch. This can create spurious patterns in the data leading to low immigrant mortality, when it is only a data artefact.

The aims of this study are to investigate mortality among immigrants in England and Wales and to determine whether immigrant mortality patterns are an actuality or a data artefact. We fit sensitivity models to examine the influence of entry and exit date uncertainty on mortality rates among immigrants. To our knowledge, this is the first empirical study in the UK to address registration uncertainty in immigrant entry dates (a delayed immigration date) and exit dates (failure to register an exit), and factor temporary exits from, and returns to the host country into analysis. Registration issues are intrinsic to register-based data; adjusting for this uncertainty in registration, and explicitly modelling the impact that it has on the robustness of immigrant mortality rates, will allow us to determine whether low immigrant mortality is a data artefact or an actuality which can be better explained other mechanisms such as selection and cultural factors.

2.2. Background

2.2.1. Data artefact

Data artefact encompasses a broad range of potential data error sources. These include the misreporting of age, misclassification of nationality or ethnicity, and registration errors relating to moves between the country of origin and the host country which mismatch deaths and populations at risk and cause numerator and denominator mismatch (Deboosere and Gadeyne, 2005). If emigrations are under-registered and deaths are undercounted, the risk population is overestimated and immigrant mortality rates are depressed (Kibele et al., 2008). Immigrants may simply forget to register an exit. However, they may have an incentive to remain on host population registries in order to further residence status or claim child benefits (Weitoft et al., 1999). Those who remain on the host registry can become statistically immortal if they die elsewhere, as they still continue to age in the host country's official statistics (Kibele et al., 2008).

Evidence of the impact of registration errors on results varies. Studies by Kibele et al. (2008) and Kohls (2010), both observe mortality underestimation in Germany. However, a counter study uses a German panel study (which avoids denominator bias) to demonstrate a similar mortality advantage to that observed in German register studies (Razum et al., 2000). Lower immigrant mortality in Sweden is largely explained by denominator bias – though advantages persist among some groups (Weitoft et al., 1999). However, correction for substantial under-registration of Moroccans in France could not account for their relative high life expectancy (Khlat and Courbage, 1996). Further, a mortality advantage among the Portuguese in France persisted after controlling for registration bias (Darmon and Khlat, 2001). The correction for undocumented emigration/late registration in Belgium had little impact on mortality (Anson, 2004).

Return migration is inherently linked to registration uncertainty (Deboosere and Gadeyne, 2005) and contributes to both numerator and denominator biases (Abraído-Lanza et al., 1999). Salmon bias proposes that immigrants return home at old ages through a strong cultural desire to die in their place of birth. This causes numerator bias, as deaths among returnees are omitted from the host country calculations (Turra and Elo, 2008) and denominator bias as individuals continue to age in host country databases if they do not register their departure. Partial evidence has been found among Mexicans in the U.S. (Palloni and Arias, 2004); a number of studies support its existence but question its impact on mortality rates (Franzini et al., 2001; Turra and Elo, 2008; Arias et al., 2010). Salmon bias cannot explain low mortality among Cubans and Puerto Ricans in the U.S. (Abraído-Lanza et al., 1999) or Turks in Germany (Razum et al., 1998).

The second, mobility bias suggests that migrants frequently return to their origin country for short or long periods (independent of their health status) given the geographic proximity of some host and origin countries e.g. South Europe and North Africa to Germany and France (Khlat and Darmon, 2003). If these departures are unregistered, individuals will continue to contribute risk-time even though they are not permanently resident in the host country. The third, the unhealthy remigration hypothesis, posits that immigrants return to their country of origin at younger ages based on socioeconomic factors which are predictive of a future high mortality risk (Razum et al, 1998; Khlat and Darmon, 2003). Like salmon bias, immigrants continue to contribute risk time if they do not register their exit from the country of origin. The unhealthy remigration effect also conspires to increase the good health of the remaining migrant sample because less successful/healthy immigrants leave while more successful and healthy immigrants choose to remain. This constitutes an out-selection process (Turra and Elo, 2008).

Additionally, there may be problems with overstating of age, particularly at advanced ages (Palloni and Arias, 2004). It has been demonstrated that some populations aged 55+ in Latin America and some Hispanics in the U.S. may overstate their age (Dechter and Preston, 1991; Rosenwaike, 1991). This can depress mortality rates and affect the age distribution of deaths (Palloni and Arias, 2004). Misclassification of ethnicity on death certificates may also occur. In the U.S., this led to recommendations that Hispanic death rates be interpreted cautiously (Markides and Eschbach, 2005). An earlier U.S. study reported a 7% under-ascertainment of ethnicity on death certificates compared with self-classification (Rosenberg et al., 1999). This 7% correction was applied to demonstrate the persistence of low relative Hispanic mortality (Elo et al., 2004). In sum, data errors may artificially lower immigrant mortality (and over-emphasise the mortality advantage) but low migrant mortality is often shown to persist after correction.

2.2.2. Selection effects

Beyond data artefact, selection effects posit the formation of a uniquely healthy population with good health and a low mortality risk. The selective effect is so strong that migrant health and mortality can be better than both country of origin and host populations, regardless of socioeconomic background (Deboosere and Gadeyne, 2005). Selection takes place before migration and effects follow the immigrants to the host country (Franzini et al., 2001). This selection may encompass the ability to overcome the physical and psychological challenges of migration (Gushulak, 2007) and selection for immigrant personality traits such as courage (Schiffauer, 1991), ambition, motivation (Uitenbroek and Verhoeff, 2002), social adeptness (Razum et al., 1998) and risk-taking (Lindstrom and Ramírez, 2010). Immigration into a new society is incompatible with health problems (Razum et al., 1998) and only those adequately healthy and capable of overcoming the difficulties of migration will succeed (Qi and Niu, 2013). However, some question the effects lasting long enough to explain low mortality after decades (Khlat and Darmon, 2003) and the ability of young people to select based on future susceptibility to disease when symptoms do not present for years (Uitenbroek and Verhoeff, 2002).

The links between health and wealth are apparent. Healthy and wealthy people are able to migrate because they have both physical ability and financial resource (Chiquiar and Hanson, 2005; McDonald and Kennedy, 2004). Yet, immigrants can have low mortality despite a poor socioeconomic status (Razum and Twardella, 2002). This is known as the Hispanic Mortality Paradox (Abraído-Lanza et al., 1999). A low socioeconomic status is linked with poor health and a high mortality risk; so it is paradoxical that Hispanics could have lower mortality than U.S.-born who have a better socioeconomic status (Palloni and Arias, 2004). However, low mortality among Hispanics is evident (Wei et al., 1996; Abraído-Lanza et al., 1999, 2005; Palloni and Arias, 2004; Turra and Elo, 2008) and this phenomenon has also been observed among Mediterranean immigrants in Germany (Razum et al., 1998), in France (Khlat and Courbage, 1996) and Belgium (Anson, 2004) and has been termed the Mediterranean Mortality Paradox.

2.2.3. Cultural factors

Cultural factors posit that immigrants practice health-protective, culture-specific behaviours which operate to produce a lower mortality risk (Scribner, 1996; Abraído-Lanza et al., 1999). Evidence finds the practice of both positive and negative behaviours among immigrants. In their respective studies, nutritional habits are more favourable among Moroccans in France (Khlat and Courbage, 1996), Turks in Germany (Bilgin et al., 1994; Razum et al., 1998) and Greeks in Australia (Powles, 1990) but all have comparable tobacco consumption to the host population. Male and female Latinos are likely to drink less and (women) smoke less, but migrants are also less likely to use preventative services (Abraído-Lanza et al., 1999). Health behaviours can also be gender-specific. Smoking rates among Moroccan, Turkish and Chinese males are higher than among females (Uitewaal et al., 2004; Li et al., 2011). Mexican, Cuban and Puerto Rican men are more than twice as likely to drink alcohol as women (Marks et al., 1990).

Despite this heterogeneity in health behaviours among immigrants, the practice of certain positive behaviours may offset the negative effects from less favourable behaviours (Powles, 1990). For example, while tobacco consumption among Moroccans is comparable to French-born non-migrants, low alcohol consumption may provide considerable protection from lung cancer (Bandera et al., 2001 in Khlat and Darmon, 2003). Further, the impact of continuing high rates of cigarette smoking, obesity, diabetes and sedentary lifestyles among Greeks in Australia is offset by the protective effects of the Mediterranean diet (Powles, 1990) – Greek immigrants continue to have low mortality relative to Australian non-migrants (Kouris-Blazos, 2002).

Cultural factors closely link with acculturation; the deterioration of health over time through the adoption of host society behaviours (Abraído-Lanza et al., 2005). Evidence indicates that health behaviours tend to worsen with acculturation (Scribner, 1996) as immigrants adopt the unhealthier behaviours often associated with a western host society (Beiser, 2005). Immigrants begin to amass risk for chronic diseases at a similar rate to the host population. At the point of migration a cultural buffer exists which differentiates migrants and non-migrants; as migrants spend time in the host country, the buffer diminishes (Jasso et al., 2004). In a review of the U.S acculturation literature, Lara et al. (2005) claim that although not absolute – as some argue that the acculturation paradigm is too simplistic (Lee et al., 2013) and can lack methodological rigor (Lara et al., 2005) – evidence indicates a negative effect of acculturation on health (substance abuse and diet) among Latinos in the U.S. though their healthcare access may improve over time.

2.2.4. Mortality among migrants in England and Wales

Previous UK research is less conclusive. Low mortality has been found among Polish, Italian, South Asian, Vietnamese, Chinese and Caribbean migrants (Marmot et al., 1983; Swerdlow, 1991; Scott and Timæus, 2013). Other studies find low mortality among young immigrants but higher mortality rates among older immigrants (Wild et al., 2007). Variation in cause-specific mortality by country of birth has also been observed (Wild et al., 2006; Wild et al., 2007). High mortality among the Irish (Wild et al., 2007) persists into second and third generations (Harding and Balajaran, 1996; Harding and Balajaran, 2001); mortality is also high among Scottish migrants (Wild et al., 2007). Studies using limiting long-term illness as a proxy show variation, with low mortality among Chinese only (Rees et al., 2009) and low mortality among Scottish migrants relative to the Scottish, but not English, non-migrant population (Wallace and Kulu, 2014).

Given findings from the literature, the migrant mortality advantage could be a data artefact, the result of an inflated denominator base and an undercount of deaths. Simultaneously, low immigrant mortality could be an actuality, best explained by a combination of selection effects and cultural factors. However, studies on data artefact rarely find that registration uncertainty accounts wholly for the migrant mortality advantage. Our three hypotheses are therefore as follows:

1 *We expect immigrants to have lower mortality than the host population in England and Wales.*

2 *We expect adjusting for registration uncertainty to reduce the mortality differences between immigrants and the England and Wales-born but we anticipate differences will persist after control.*

3 *We expect the migrant mortality advantage among immigrants (if any) to become more pronounced once we have adjusted for the individual socioeconomic characteristics of migrants.*

2.3. Methods

2.3.1. The Office for National Statistics Longitudinal Study (LS)

The LS is a continuous multi-cohort study which links census and life event information for a nationally representative 1% sample of the population living in England and Wales. The original sample was selected from the 1971 Census and linked census and life event data on individuals born on one of four dates of birth. Information on these people has been updated at the censuses in 1981, 1991 and 2001 and, throughout this time, new members (as long as they were born one of four anonymous dates) could enter into the LS either at the time of the next census or through registering with the National Health Service (NHS) between census years (Hattersley and Creeser, 1995). Information on life events has been added to the LS since 1971. Events include new births and immigrations (entry events) and deaths and emigrations (exit events). Migration data are taken from NHS registration systems (described below); data on births and deaths are taken from civil registration data. Data on over one million people has been collected for over thirty years. At each census, data on approximately 500,000 people is collected.

2.3.2. Entry into the LS

Entry into the LS is recorded when an immigrant registers with a doctor and joins the NHS or when an individual completes a census form. A healthy individual may not register with a doctor until their services are required. Although the date of entry into a country is asked for on the doctor's application list, it is not crosschecked against any other sources and can be inaccurate (Hattersley, 1999). The LS may also miss those individuals who utilise private healthcare, short-term immigrants who emigrate after at least one year who have not registered with the NHS during their residence in England and Wales and any European workers whose country of origin have a reciprocal arrangement with the National Health Service (Hattersley, 1999).

2.3.3. Exit from the LS

Exit from the LS occurs through death or emigration. Death certificates are a legal requirement and the quality of death data in England and Wales is known to be very high. Delays only occur if an inquest is deemed necessary or an individual died while abroad. For individuals leaving England and Wales, the NHS advises all patients to inform their doctor of their intention to de-register from the NHS. The ONS then receives an annual file from NHS registration systems which includes records of any LS members who have embarked and de-registered from the National Health Service (ONS 2015). The records of these LS members are retained even if individual's die or emigrate. However, there can be problems with the non-registration of exits. If an LS member does not notify the NHS of their emigration they will have no exit date and they become *lost to follow-up* (LTFU) (7; see figure 2.1) when no exit date is recorded and the LS member is not enumerated at any subsequent censuses and does not record any more life events.

However, because the LS includes more than one census point, we can identify the decade of exit. If the individual is not present at the next census (having been enumerated at the last) and has not contributed events in the intercensal period, they can be exited from the study prior to the census where they have been found to be missing (Hattersley, 1999). By doing this, the LS member will contribute risk-time to the denominator only while they are known to be alive and likely still in the country (Hattersley, 1999). While we assume that all those 'lost to follow-up' are unrecorded embarkations from England and Wales, people can also be lost if they are under-enumerated at census or if corroborating information is recorded either at census or with the NHS. Ultimately, it is not possible to provide answers as to how every individual is 'lost to follow-up'. Those who are lost are more likely to be young and male, born outside of England and Wales and be an ethnic minority. They account for 13% of the dataset (Blackwell et al., 2003). However, as Table 2.1 shows loss to follow-up rates vary substantially by country of birth. We would expect a more pronounced effect on mortality rates for countries (or country groups) such as Jamaica and Other Caribbean who have much higher levels of lost to follow-up.

Table 2.1. Rates of lost to follow-up by country

Countries	Other event	Lost to follow-up	
		Freq	%
England and Wales	718,501	92,971	11.5
Scotland	12,676	4,361	25.6
Northern Ireland	3,996	875	18.0
Ireland	9,496	3,602	27.5
India	13,991	3,463	19.8
Pakistan	8,203	1,975	19.4
Bangladesh	4,144	858	17.2
Jamaica	2,644	1,403	34.7
Other Caribbean	2,075	984	32.2
East & South Africa	7,509	1,661	18.1
West & Central Africa	4,349	1,641	27.4
Western Europe	12,834	5,070	28.3
Eastern Europe	14,761	1,468	9.0
China	3,232	1,105	25.5
Other Asia	6,874	2,321	25.2
Rest of World	22,006	9,317	29.7
Total	**847,291**	**133,075**	**13.6**

Note: "Other event" is censoring, death, or registered exit.
Source: author's calculations based on the ONS LS

2.3.4. Temporary exits and re-entries in the LS

The LS records temporary exits and returns from England and Wales, these are captured in the same way as entries and exits. For these events there are two types of residence trajectory. There are those with consistent cases where individuals can be continually resident (there are no recorded exits or re-entries) and non-continually resident (there are chronological exits and re-entries) and inconsistent cases where there is a missing value or unchronological sequence (Robards et al., 2011). Those with consistent, continually resident cases are at risk of death until they experience the final event or censoring. LS members with consistent, non-continually resident cases have both at risk and out of risk periods. These are taken into account to ensure out of risk periods do not inflate the denominator (see trajectory diagrams in Robards et al., 2011).

LS members with inconsistent cases have either (i) an unchronological event sequence e.g. an exit date is later than its partnered re-entry date or (ii) information is missing. Those with an unchronological event sequence are dropped because we cannot determine risk-time and there are cases where the date of events are far apart. If a case is inconsistent because of a missing value, we impute a value of the partnered event minus 12 months. This is conditional upon the timing of any event before the missing value being at least 13 months so as not to create any further inconsistency. We do this because immigrants are more likely to record exits and re-entries and we do not want to reduce our sample size. We drop 700 individuals and impute values for 6,000. Nearly all missing values occur where there is a value for re-entry 1 but not exit 1.

2.3.5. Modelling registration uncertainty

Given the uncertainty surrounding defining the correct denominators required for calculating accurate immigrant mortality rates, we implement the following scenarios (fitting sensitivity models) to assess the impact of possible denominator bias. Under exit control, we project three different scenarios based on the empirical distribution of known exits from the dataset (approximately 9,000 individuals see Table 2.1). Exits of known individuals are measured as number of years after final census appearance. We take the median and upper/lower quartiles to define the exit scenarios. Exit scenario A projects an early exit (2-years after census for 'lost to follow-up'), scenario B a middle exit (4-year exit) and scenario C a late exit (7-year exit)[2][3]. In the exit models, we allow the immigrants to enter between censuses (i.e. we do not restrict entry).

Table 2.2. Recorded exits per year from the LS by census decade.

Years after	1971-1981		1981-1991		1991-2001		Total	
census	*Exits*	*%*	*Exits*	*%*	*Exits*	*%*	*Exits*	*%*
0-1	574	15	470	19	320	13	1,364	16
1-2	557	30	382	35	340	27	1,279	30
2-3	602	45	248	45	274	38	1,124	43
3-4	575	60	177	52	276	49	1,028	55
4-5	366	70	153	58	204	58	723	63
5-6	261	77	143	64	202	66	606	70
6-7	244	83	204	72	186	73	634	77
7-8	244	89	207	81	219	82	670	85
8-9	200	95	235	90	208	91	643	92
9-10	208	100	234	100	227	100	669	100
Total	**3,831**		**2,453**		**2,456**		**8,740**	

Source: author's calculations based on the ONS LS

[2] *Results from additional sensitivity models (5 and 8-years after exit) are available in Appendix B (Table B4)*
[3] *Table B6 in Appendix B shows hazard ratios for immigrants excluding those who become 'lost to follow-up'*

Note: the table shows recorded exits from the LS by census decade. This is measured as years after final census. This distribution informs our exit scenarios for those ‘lost to follow-up’. The value of quartiles are measured as Q1 = 1.83; Q2 = 3.91; Q3 = 6.96 (i.e. 2-, 4- and 7-years after census).

In the entry scenario, we first do not allow intercensal entries and limit the onset of risk to first census appearance (we project the middle exit [4-year] scenario for those ‘lost to follow-up’). However, it should be noted that while adjusting entry provides a higher certainty of presence (because an individual has to fill in a census form to be enumerated), it reduces risk-time and leads to mortality overestimation, particularly when there are few (if any) deaths between intercensal entry and the first census appearance. Most immigrants experience a delay in their registration (many do not register immediately on arrival, some are young and healthy and may not feel the need to register), suggesting that risk-time is already reduced. In the conservative model we limit entry to first census appearance and project an early exit scenario (2-years after census).[4]

Figure. 2.1 outlines these scenarios. In the example, unadjusted, the immigrant enters in 1985 and last appears at the 1991 census (they are then ‘lost to follow-up’), contributing an unknown risk period to the denominator. Under the three exit scenarios we project exit dates of 1993 (2-years), 1995 (4-years) and 1998 (7-years) for the immigrant. This contributes risk periods of 8, 10 and 13-years respectively. Under the entry scenario, we limit the immigrant's entry date to 1991 (the date of the census) and project an exit in 1995, contributing a risk period of 4-years. Finally, under the conservative scenario, the immigrant enters at census in 1991 and exits in 1993, contributing a risk period of 2-years. Across models we see a minimum contribution to the denominator of 2-years and a maximum contribution of 13-years. Across scenarios the non-migrant contributes an unchanged risk period (unless the individual also does not record an emigration; in which case they also become ‘lost to follow-up’ and are subject to the same exit scenarios).

2.3.6. Defining first generation immigrants

Migrant status is defined by country of birth. Country of birth is a question asked at each census from 1971 to 2001. For people present at multiple censuses, we take the country specified most frequently at census. For example, someone present across four censuses will be assigned a

[4] *The conservative model is not presented in chapter I but is in Appendix B (Table B5)*

definitive country if they have selected the same country at least three times out of four. An individual present across two or three censuses will be assigned a country if they have selected the same country of birth at two censuses. An individual present at one census is assigned the country selected at that census. Approximately 6000 individuals (<1% of the sample) had ties (multiple modes). Resultantly, we used certain assumptions (described below) to reduce this value.

Individuals whose modes are tied between a UK and foreign country are assigned the latter as a country of birth; especially as in many of these instances this is the country specified first. This also helps to maximise the number of immigrants available for analysis. Individuals who are tied as a result of non-definitive answers e.g. Pakistan/Bangladesh (in 1971) and Ireland Part Not Stated (1971 and 1981) are assigned their later answer when individuals were able to specify, or chose to specify, a more detailed answer. Making these assumptions reduced the multiple mode category to less than 2,000 individuals. Remaining individuals are included in models under the category 'unresolvable'. It should be noted that a small number of British citizens who were born abroad may be included in the sample of migrants. However, due to the age design of our study (see statistical methods) the majority of British expatriates born in India, Pakistan and Bangladesh should be excluded from the final analysis (Marmot et al., 1984).

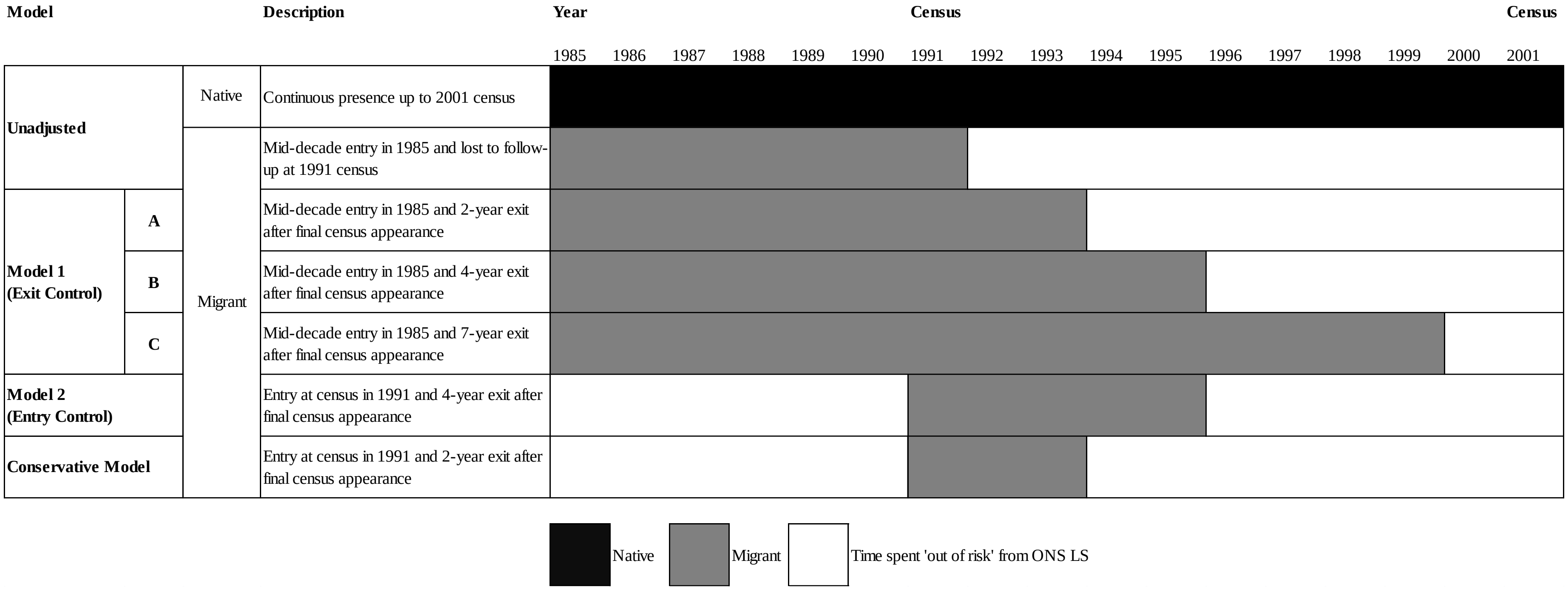

Figure 2.1. Scenarios for addressing registration uncertainty in the LS.

Source: author's calculations based on ONS LS

2.3.7. Study sample

The original LS sample was 851,416 individuals. LS members were removed from the dataset if they were untraced (*18,356*). LS members are untraced when their records cannot be found in the NHS register. We cannot match census information with any life events they may have experienced; resultantly we are unable to study these individuals longitudinally. LS sample members were dropped because they had inconsistent exit and re-entry dates (*623*), or they had discrepant entry, death, or date of birth values (*169*) which were either missing or conflicting. The comparison of all of the excluded cases (*2.2%*) with the sample cases by socio-demographic characteristics shows that untraced LS members (who make up the majority of the excluded cases) are likely to be younger and come from a country outside of England and Wales.

Table 2.3. Mortality rates in LS relative to Human Mortality Database.

Age		**1971-1981**		**1981-1991**		**1991-2001**	
(years)	HMD	LS	95% CI	LS	95% CI	LS	95% CI
20-24	*1.00*	0.80	0.70 - 0.91	1.02	0.91 - 1.15	1.03	0.90 - 1.20
25-29	*1.00*	0.89	0.79 - 1.01	1.06	0.95 - 1.19	0.95	0.83 - 1.09
30-34	*1.00*	1.00	0.90 - 1.11	1.05	0.95 - 1.16	0.93	0.82 - 1.06
35-39	*1.00*	0.89	0.81 - 0.98	0.94	0.86 - 1.03	0.92	0.83 - 1.03
40-44	*1.00*	0.90	0.84 - 0.97	0.95	0.88 - 1.02	0.96	0.88 - 1.05
45-49	*1.00*	0.93	0.88 - 0.98	0.90	0.85 - 0.96	0.91	0.85 - 0.98
50-54	*1.00*	0.95	0.91 - 0.99	0.89	0.85 - 0.94	0.90	0.85 - 0.95
55-59	*1.00*	0.98	0.95 - 1.02	0.92	0.89 - 0.96	0.92	0.88 - 0.97
60-64	*1.00*	0.99	0.96 - 1.01	0.97	0.94 - 0.99	0.91	0.88 - 0.95
65-69	*1.00*	0.99	0.97 - 1.01	0.97	0.95 - 0.99	0.92	0.89 - 0.94
70-74	*1.00*	0.98	0.96 - 1.00	0.97	0.95 - 0.99	0.95	0.93 - 0.97
75-79	*1.00*	0.98	0.96 - 1.00	0.98	0.96 - 1.00	0.97	0.95 - 0.99
80-84	*1.00*	0.98	0.96 - 0.99	0.98	0.97 - 1.00	0.95	0.93 - 0.97
85-89	*1.00*	0.98	0.96 - 1.00	0.97	0.95 - 0.99	0.98	0.96 - 1.00
90+	*1.00*	1.02	0.99 - 1.05	1.05	1.02 - 1.08	1.07	1.05 - 1.10

Source: author's calculations based on the ONS LS

The lower age limit in the study is set to age 20-years old. Due to low cell counts across all migrant groups above middle age in the early years of the LS, we set the upper age limit to 45 years of age in 1971.We increase this upper value by an age versus year interval of 1x1 (i.e. by one year each year) until the end of the study window at the 2001 Census where the limit is 75-years. Given how critical age is to mortality, this ensures comparability between the England and Wales-born population and immigrant groups. Our final study sample consists of 453,352 people.

We compared mortality rates in England and Wales from the LS with mortality rates in the UK from the Human Mortality Database (HMD) for decades 1971-81, 1980-91 and 1991-01. The comparison shows that the age-specific death rates are slightly lower for the LS data than for the HMD particularly for ages younger than 60-years (Table 2.2). However, for most cases the differences lie within 95% confidence intervals around estimates obtained from the LS data and in all cases within the 90% confidence intervals. As expected, the confidence intervals are much wider for younger ages and narrower for much older ages as the number of death events increases.

2.3.8. Statistical methods

We use survival analysis to study mortality among immigrants relative to the England and Wales-born population. The basic model is as follows:

$$\mu_i(t) = \mu_0(t) \times \exp\left\{\sum_j \beta_j x_{ij}(t)\right\}, \quad (1)$$

where $\mu_i(t)$ denotes the hazard (or the 'force') of mortality for individual i at age t and $\mu_0(t)$ denotes the baseline hazard, i.e. the mortality risk by age, which we assume to follow Gompertz distribution (where the hazard of mortality increases exponentially as age increases)[5]; individuals are under the risk at entry (age 20 or the age at immigration if older) and are followed until the event of death, emigration or right-censoring at April 2001 (the date of the 2001 census), whichever comes first. $x_{ij}(t)$ represents the values of a variable measuring an individual's socio-demographic background; β_j is the parameter estimate for the variable. Age is calculated in century-months to reduce the number of ties in events and censoring times and so as to be able to parametrise the baseline hazard at smaller intervals. As the day and month of birth for LS members are anonymous, July (the middle of the year) is taken as the month of birth.

Model 1 is a series of sensitivity analyses and investigates the mortality differences between immigrants and the host population using the exit scenarios defined for those 'lost to follow-up'. Model 1 controls for sex, period (1971-81, 1981-91 and 1991-01) and country of birth. Model 1a projects an early exit (2-year), 1b a middle exit (4-year) and 1c a late exit (7-year). Model 2 fits entry uncertainty (limiting entry to first census appearance) and controls for sex, period and country of birth. Model 3 controls for sex, period, the country of birth and

[5] *Table B9 in Appendix B shows hazard ratios for immigrants using different specifications of the baseline hazard (Cox and Piecewise constant specifications) – results are very similar to a Gompertz specification of the baseline hazard*

socioeconomic characteristics to observe where the latter can explain any remaining mortality differences between immigrants and the host population. Model 4 stratifies Model 3 by sex. Both Models 3 and 4 allow for intercensal entries and project a 4-year (middle) exit for ‘lost to follow-up’ based on the sensitivity analysis. Model 1b is the reference model for Models 1 to 4.

Table 2.4. Person-years at risk and number of events by covariates.

	Risk-time	%	Events	%		Risk-time	%	Events	%		Risk-time	%	Events	%
Sex					**Country of Birth**					**Education Level**				
Male	50,440,288	50.0	16,467	61.7	England	87,617,074	87.0	22,843	85.6	Degree level +	5,748,367	6.0	896	3.4
Female	50,564,447	50.0	10,233	38.3	Scotland	1,814,278	2.0	678	2.5	> A-level	6,916,052	7.0	1,121	4.2
Period					Northern Ireland	537,772	1.0	210	0.8	< A-level	80,873,985	80.0	22,407	83.9
1971-81	24,192,900	24.0	3,084	11.6	Irish Republic	1,513,422	1.0	663	2.5	Unspecified	1,402,382	1.0	140	0.5
1981-91	34,984,630	35.0	7,452	27.9	India	1,879,303	2.0	513	1.9	Missing	6,063,949	6.0	2,136	8.0
1991-01	41,827,205	41.0	16,164	60.5	Pakistan	990,901	1.0	177	0.7	**Occupation Type**				
Age (Years)					Bangladesh	360,518	0.0	71	0.3	Prof/Managerial	19,352,876	19.0	4,331	16.2
20-24	13,738,972	14.0	695	2.6	Jamaica	538,880	1.0	217	0.8	Skilled	47,242,431	47.0	11,843	44.4
25-29	14,160,002	14.0	753	2.8	Other Caribbean	406,388	0.0	111	0.4	Unskilled	5,030,607	5.0	1,736	6.5
30-34	13,808,115	14.0	944	3.5	East and South Africa	765,898	1.0	113	0.4	Unspecified	23,314,872	23.0	6,654	24.9
35-39	13,096,548	13.0	1,195	4.5	West and Central Africa	291,717	0.0	51	0.2	Missing	6,063,949	6.0	2,136	8.0
40-44	12,419,201	12.0	1,905	7.1	Western Europe	1,225,456	1.0	231	0.9					
45-49	11,142,316	11.0	2,804	10.5	Eastern Europe	368,337	0.0	198	0.7					
50-54	8,795,236	9.0	3,554	13.3	China	235,928	0.0	47	0.2					
55-59	6,369,754	6.0	4,281	16.0	Other Asia	520,028	1.0	69	0.3					
60-64	4,291,723	4.0	4,608	17.3	Rest of World	1,704,563	2.0	385	1.4					
65-69	2,415,792	2.0	3,974	14.9	Unresolvable	234,272	0.0	123	0.5					
70+	767,076	1.0	1,987	7.4						**Total**	**101,004,735**	**100**	**26,700**	**100**

Source: author's calculations based on the ONS LS

The socioeconomic characteristics that we adjust for are education level (high [higher degree level and degree], middle [higher than A-level], low [lower than A-level] or missing) and the occupation type (professional/managerial [professional, managerial and technical], skilled [skilled manual and non-manual and partly-skilled], unskilled [unskilled and armed forces] and missing). Education level and occupation type are both time-varying covariates (to allow for e.g. greater educational attainment over time) which are measured at population census. Table 2.3 shows the distribution of risk-time and deaths by the covariates in the study using person-years.

Model 5 specifies migrant status as an interaction term to observe whether mortality by age follows different patterns for immigrants and the host population. This acts as a proxy for time since entry. To fit the model it is necessary to aggregate country of birth to neighbouring (*Scotland, Republic of Ireland and Northern Ireland*), South Asian (*India, Pakistan and Bangladesh*), African/Caribbean (*Jamaica, Other Caribbean, East and Southern and West and Central Africa*), China/Other Asia and European/Other (*Eastern and Western Europe and Other*) due to limits placed on interaction models. The interaction term is defined by the binary 0=England and Wales, Scotland, Irish Republic and Northern Ireland; 1 migrant=international immigrants. We use a likelihood ratio test to compare the fit of the two nested models (3 and 5).

2.4. Results

Models 1a-c (Table 2.4)[6] control for sex, period and country of birth and project exit scenarios of 2, 4 and 7-years after census for individuals who are ‘lost to follow-up’. Mortality rates for immigrants relative to the England and Wales-born population are highest in model 1a and lowest in model 1c as we increase risk-time and thus inflate the denominator base. We observe persistent, low mortality among immigrants from Pakistan, Western Europe and Other Asia across models. Mortality is relatively high among immigrants from Scotland, the Republic of Ireland and Northern Ireland. For immigrants from Jamaica, we observe high mortality rates but the difference to the England and Wales-born host population is significant in model 1a only.

[6] *Models display hazard ratios, significance levels and 95% confidence intervals. All models from Chapter I are reproduced in Appendix B (Tables B1-B3) and additionally display the log hazard, standard errors, z-scores and values for constant*

Model 2 (Table 2.4) controls for sex, period and country of birth and controls entry, limiting onset of risk among immigrants to first census appearance. For those ‘lost to follow-up’, the model projects the 4-year exit scenario. Mortality levels are higher for immigrants compared to 1b as we deflate the denominator by limiting entry to immigrants’ first census appearance. Again we find high mortality among immigrants from Scotland, the Irish Republic and Northern Ireland and low mortality among immigrants from Western Europe and Other Asia. The estimated mortality levels are also lower for Pakistan and Bangladesh, but the difference compared to the host population becomes insignificant when adjusting for the entry time of immigrants.

Model 3 (Table 2.4) controls for sex, period, country of birth, education level and occupation type. Given results from models 1 and 2 and that immigrant mortality rates have been observed to be robust to changes in the denominator, model 3 allows immigrants to enter intercensally and projects a 4-year exit for those ‘lost to follow-up’. As expected mortality levels are lower for females and those with higher education level and occupation type; mortality rates have declined over time. Once we adjust for education level and occupation type, the mortality advantage among immigrants becomes pronounced; most immigrants now have low mortality relative to England and Wales-born. Low mortality is observed among South Asians, Other Caribbeans, East and South Africans, Western Europeans, Chinese and Other Asians. Mortality among those born in Jamaica, Eastern Europe and West and Central Africa are similar to White England and Wales-born. A small decrease in mortality is observed among Northern Irish and Irish.

Model 4 (Table 2.5) stratifies by sex and controls for period, country of birth, education level and occupation type. Model 4 does not control entry and projects the 4-year exit scenario for those ‘lost to follow-up’. We find consistent, low mortality among males and females from India, Pakistan, Bangladesh, Western Europe and Other Asia. Males from Other Caribbean and East and South Africa have low relative mortality; respective females reflect the host baseline. Females from China have very low relative mortality; Chinese males have a low value which is not significant. We see consistent high mortality levels for males and females from Scotland, Northern Ireland and the Irish Republic. When stratified by sex, Jamaican men have lower mortality than the England and Wales-born but Jamaican migrant women have high relative mortality.

Model 5[7] (Fig. 2.2) show results from the age interactions (the model fit improved significantly: LR = 5.7, with d.f. = 1, and $p < 0.05$) (for the sake of simplicity, we fit a sex-adjusted rather than sex-stratified model). We observe some differences between immigrants and England and Wales-born at age 20-years for all immigrant groups; China and Other Asia and South Asia have particularly marked migrant mortality advantages. Mortality converges towards baseline mortality over time (signified as 1.00 on the Y axis). At older ages mortality of African and Caribbean migrants and group Other converges to England and Wale-born. Mortality among South Asian and Chinese/Other Asians is still converging but by age 80-years mortality is still low.

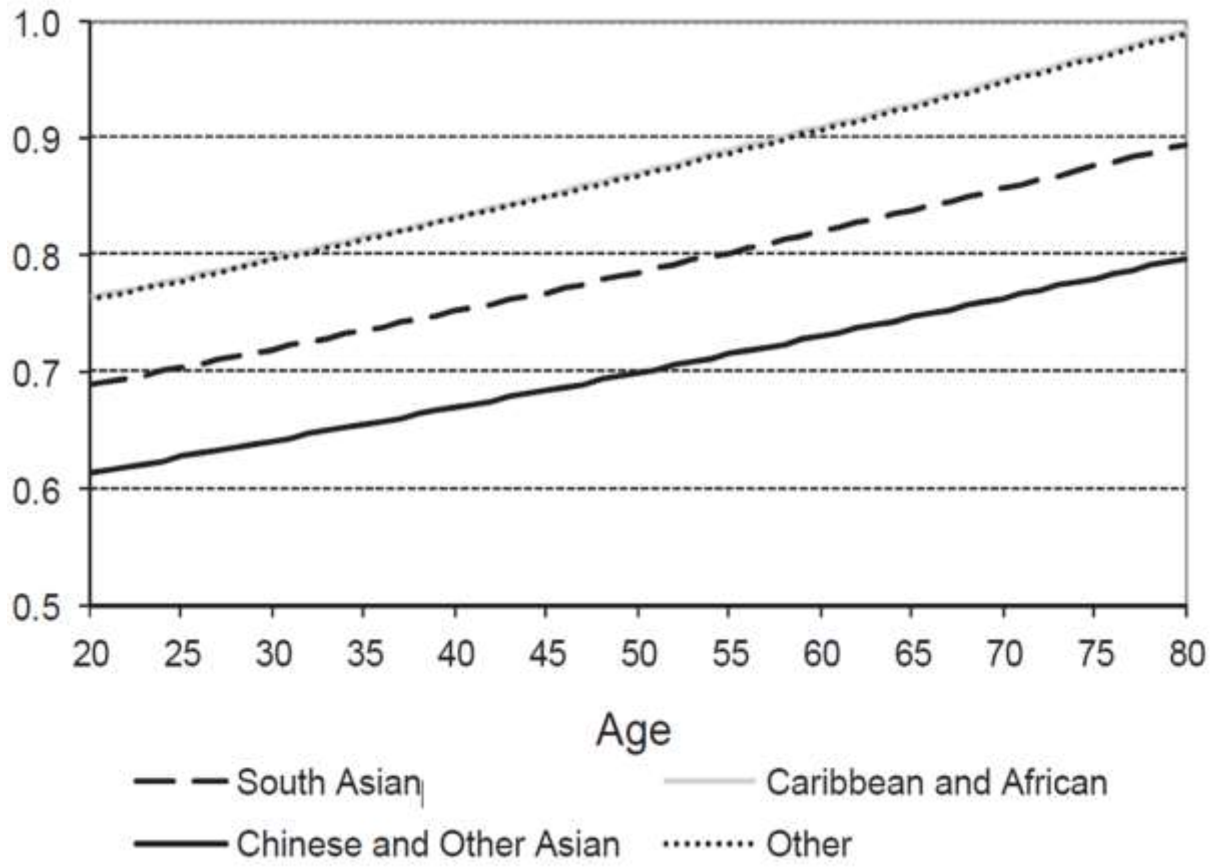

Figure 2.2. Hazard ratios: age interactions in mortality among immigrants relative to England and Wales-born.

<u>Notes:</u> Value "1.00" on Y axis signifies mortality among England and Wales-born

Source: author's calculations based on the ONS LS

[7] *The interaction and main effects model and the values calculated from these models are available in Appendix B (Tables B7 and B8)*

Table 2.5. Hazard ratios: sensitivity analysis registration uncertainty: mortality among immigrants relative to England and Wales-born.

	Model 1									Model 2			Model 3		
	[A]			[B]			[C]								
	Haz Ratio	Sig	95% CI	Haz Ratio	Sig	95% CI	Haz Ratio	Sig	95% CI	Haz Ratio	Sig	95% CI	Haz Ratio	Sig	95% CI
Sex															
Male	**1**			**1**			**1**			**1**			**1**		
Female	0.61	***	0.59 - 0.62	0.61	***	0.59 - 0.62	0.61	***	0.59 - 0.62	0.61	***	0.59 - 0.62	0.49	***	0.48 - 0.50
Period															
1971-1981	**1**			**1**			**1**			**1**			**1**		
1981-1991	0.91	***	0.87 - 0.95	0.91	***	0.87 - 0.95	0.90	***	0.86 - 0.94	0.90	***	0.86 - 0.94	0.92	***	0.89 - 0.97
1991-2001	0.87	***	0.83 - 0.91	0.86	***	0.82 - 0.90	0.84	***	0.80 - 0.88	0.85	***	0.82 - 0.89	0.88	***	0.85 - 0.93
Country of Birth															
England and Wales	**1**			**1**			**1**			**1**			**1**		
Scotland	1.30	***	1.20 - 1.40	1.28	***	1.19 - 1.38	1.26	***	1.16 - 1.36	1.29	***	1.20 - 1.40	1.28	***	1.19 - 1.39
Northern Ireland	1.28	***	1.12 - 1.47	1.27	***	1.11 - 1.46	1.25	***	1.09 - 1.43	1.31	***	1.14 - 1.50	1.22	***	1.06 - 1.39
Irish Republic	1.24	***	1.14 - 1.33	1.22	***	1.13 - 1.31	1.18	***	1.09 - 1.28	1.24	***	1.15 - 1.34	1.11	***	1.02 - 1.20
India	1.00		0.91 - 1.09	0.98		0.90 - 1.07	0.95		0.87 - 1.04	1.04		0.95 - 1.13	0.89	***	0.81 - 0.97
Pakistan	0.87	*	0.75 - 1.01	0.85	**	0.73 - 0.99	0.81	***	0.70 - 0.94	0.92		0.79 - 1.06	0.69	***	0.59 - 0.79
Bangladesh	0.85		0.68 - 1.08	0.83		0.66 - 1.05	0.79	**	0.62 - 0.99	0.94		0.75 - 1.19	0.62	***	0.49 - 0.78
Jamaica	1.13	*	0.98 - 1.29	1.09		0.96 - 1.25	1.04		0.91 - 1.19	1.11		0.97 - 1.26	0.97		0.84 - 1.10
Other Caribbean	0.93		0.77 - 1.13	0.90		0.75 - 1.09	0.86		0.71 - 1.03	0.93		0.77 - 1.12	0.85	*	0.70 - 1.02
East and South Africa	0.90		0.75 - 1.08	0.89		0.74 - 1.07	0.87		0.72 - 1.04	1.00		0.83 - 1.20	0.82	**	0.68 - 0.98
West and Central Africa	0.99		0.75 - 1.30	0.95		0.72 - 1.25	0.88		0.67 - 1.16	1.10		0.84 - 1.45	0.84		0.64 - 1.10
Western Europe	0.72	***	0.63 - 0.82	0.70	***	0.62 - 0.80	0.68	***	0.60 - 0.78	0.73	***	0.64 - 0.83	0.68	***	0.60 - 0.78
Eastern Europe	1.05		0.91 - 1.20	1.03		0.90 - 1.19	1.01		0.88 - 1.17	1.07		0.93 - 1.23	0.96		0.84 - 1.11
China	0.86		0.64 - 1.14	0.83		0.63 - 1.11	0.80		0.60 - 1.06	0.92		0.69 - 1.22	0.75	**	0.56 - 0.99
Other Asia	0.74	**	0.58 - 0.94	0.72	***	0.57 - 0.91	0.69	***	0.55 - 0.88	0.82		0.65 - 1.04	0.68	***	0.54 - 0.86
Rest of World	0.98		0.89 - 1.09	0.96		0.87 - 1.06	0.91	*	0.83 - 1.01	1.04		0.94 - 1.15	0.89	**	0.81 - 0.99
Unresolvable	2.06	***	1.72 - 2.45	1.99	***	1.66 - 2.37	1.87	***	1.56 - 2.23	2.06	***	1.73 - 2.46	1.61	***	1.35 - 1.93
Education Level															
Degree level +													**1**		
> A-level													1.19	***	1.09 - 1.31
< A-level													1.57	***	1.46 - 1.68
Unspecified													1.81	***	1.50 - 2.17
Missing						*(Socioeconomic characteristics not adjusted for)*							3.13	***	2.90 - 3.39
Occupation Type															
Professional/Managerial													**1**		
Skilled													1.21	***	1.17 - 1.26
Unskilled													1.52	***	1.43 - 1.61
Missing													2.20	***	2.11 - 2.30

Note: Missing in occupation type omitted from model. *Source: author's calculations based on the ONS LS*

Table 2.6. Hazard ratios: mortality among immigrants relative to England and Wales-born by sex.

Model 4	Male			Female		
	Haz Ratio	Sig	95% CI	Haz Ratio	Sig	95% CI
Period						
1971-1981	**1**			**1**		
1981-1991	0.91	***	0.86 - 0.96	0.91	***	0.85 - 0.98
1991-2001	0.82	***	0.76 - 0.87	0.90	***	0.84 - 0.97
Country of Birth						
England and Wales	**1**			**1**		
Scotland	1.25	***	1.13 - 1.38	1.35	***	1.19 - 1.53
Northern Ireland	1.21	**	1.02 - 1.43	1.20		0.96 - 1.51
Irish Republic	1.06		0.96 - 1.18	1.14	**	1.01 - 1.29
India	0.90	**	0.81 - 1.00	0.84	**	0.72 - 0.98
Pakistan	0.68	***	0.57 - 0.81	0.66	***	0.50 - 0.88
Bangladesh	0.59	***	0.45 - 0.77	0.60	**	0.36 - 0.97
Jamaica	0.75	***	0.62 - 0.90	1.34	***	1.10 - 1.62
Other Caribbean	0.77	**	0.61 - 0.97	0.97		0.72 - 1.32
East and South Africa	0.72	**	0.56 - 0.91	0.96		0.72 - 1.27
West and Central Africa	0.87		0.64 - 1.19	0.68		0.37 - 1.22
Western Europe	0.72	***	0.60 - 0.87	0.65	***	0.54 - 0.78
Eastern Europe	0.97		0.81 - 1.15	0.92		0.72 - 1.17
China	0.83		0.61 - 1.15	0.52	**	0.27 - 0.99
Other Asia	0.64	**	0.46 - 0.87	0.70	*	0.49 - 1.01
Rest of World	0.90		0.80 - 1.03	0.85	*	0.72 - 1.00
Unresolvable	1.35	**	1.07 - 1.71	2.03	***	1.55 - 2.67
Education Level						
Degree level +	**1**			**1**		
> A-level	1.19	***	1.07 - 1.33	1.09		0.92 - 1.29
< A-level	1.56	***	1.44 - 1.70	1.50	***	1.29 - 1.74
Unspecified	1.43	***	1.13 - 1.82	2.12	***	1.57 - 2.86
Missing	3.17	***	2.90 - 3.48	2.78	***	2.36 - 3.27
Occupation Type						
Professional/Managerial	**1**			**1**		
Skilled	1.24	***	1.18 - 1.30	1.10	**	1.02 - 1.18
Unskilled	1.60	***	1.49 - 1.71	1.27	***	1.15 - 1.41
Unspecified	2.92	***	2.76 - 3.09	1.67	***	1.55 - 1.80

Note: Missing in occupation type omitted from model.
Source: author's calculations based on the ONS LS

2.5. Discussion

Our analysis has shown that most international immigrants have lower mortality than the host population in England and Wales, although the presence and size of the migrant mortality advantage varies by country of birth. Mortality differences between immigrants and England and Wales-born largely persist when we adjust for registration uncertainty and they become pronounced upon control for socioeconomic status. The sex-stratified estimates predominantly showed consistency between men and women by country of birth. The interactions suggested declining mortality differences between the host population and immigrants as age increases; though most immigrants still had low relative mortality in all ages. Most importantly, our study has found that low mortality among immigrants is not a data artefact. The findings are largely consistent with other studies. We consider selection and cultural factors as the reasons for low mortality.

The results from the interaction model showed that mortality among immigrants was lowest at age 20 and attenuated over age to the mortality level among the host population. Figure B1 (in Appendix B) shows the age at migration for the migrant groups in the study. A large proportion of all of the groups (except Jamaica) enter between 20 and 35, with only a small proportion of entries thereafter. These results, combined with the results from the age interaction model, are consistent with both selection effects and acculturation. The mortality advantage is strongest at younger ages when many immigrants have just moved to the country and selection effects are strongest. The advantage wears off over time as migrants acculturate to the host society and the migrant stock stops being replenished by newly-selected immigrants from the country of origin.

Selection theory proposes that migrants constitute a self-selected population with good health status and low mortality risk. Given the year the LS was founded, it is likely that many of the migrants enumerated in the initial 1971 sample are pioneer immigrants from the post-war Commonwealth labour movement (1945-1962). The most selective of international migrants are the first to leave for destinations. Pioneer migrants do not benefit from the information and support provided by pre-established migrant networks that facilitate reaching a destination, gaining employment and finding accommodation after arrival (Lindstrom and Ramírez, 2010). Pioneer migrants thus have to be very socially-adept, resilient and embracers of risk in order to succeed in the establishment of new migrant communities and social networks in the host country.

Following the establishment of these new migrant communities, continuing self-selection by individuals from origin countries is likely to contribute to the persistent low mortality among migrants. While communities and networks are now established, individuals still have to travel long-distances and integrate into a new host society. This initial selection may be accentuated by the return migration of individuals who are already unwell, or alternatively of those who are likely to experience ill-health and a higher future mortality risk. This can be seen as a method of indirect selection for factors innately linked to both socio-occupational skills and health (Khlat and Darmon, 2003). Low mortality found among Western Europeans may be a result of this selection in return migration, given its geographical proximity to England and Wales. However, evidence for large-scale health-motivated return migration is inconclusive (Razum et al., 1998; Franzini et al., 2001; Palloni and Arias, 2004; Turra and Elo, 2008; Arias et al., 2010).

The sex-stratified estimates also provide support for selection effects. Given that there are good reasons to expect male and female immigrants to have different mortality, we find consistency by sex across many countries: India, Pakistan, Bangladesh, Western Europe, Eastern Europe, Other Asia and the Rest of the World. This consistency persists despite potential different reasons for migration. Traditionally, the literature suggests that women migrate for family reunification (Hondagneu-Sotelo and Cranford, 2006) playing a secondary, supportive role to males in the migration process (Shauman and Noonan, 2007). If this is the case, we would expect that women would not select for good health status and therefore lower mortality upon migration. This is not reflected in the results; for some countries mortality is lower among women.

The sex-stratified results for Jamaica show low mortality among men and high mortality among women. If we discount gendered migration and assume that men and women both select into immigration, differences may be a result of sex-specific health behaviours. Women drink and smoke less than men, but are much more likely to be obese, and have both bigger waist circumferences and waist-to-hip ratios (Wilks et al., 2008; NOO, 2011). These measures are associated with higher cardiovascular disease risk. Analysis of cause-specific mortality would improve our understanding of differential mortality by sex among Jamaicans in England and Wales.

Health behaviours may also explain low mortality among immigrant in England and Wales. Indians (women), Pakistanis and Bangladeshis are least likely to drink above government guidelines (ONS, 2005). General drinking rates remain low for Pakistanis and Bangladeshis, Black Africans and Black Caribbeans consume more alcohol than South Asians and Chinese, but still less than the general population (Hurcombe et al., 2010). The countries comprising Western and Eastern Europe both have comparable to high drinking rates (WHO, 2014). Cigarette consumption varies by country and sex, with low rates among Indian, Pakistani, Bangladeshi and Chinese women and higher rates (but still below England and Wales levels) for men (ONS, 2005). Bangladeshi and Black Caribbean men both have a higher smoking rate than the host population and women from their respective countries (ONS, 2005). Many of the countries comprising Western and Eastern Europe have comparable to higher smoking rates than England and Wales (Zatoński et al., 2012) with less variation by sex. Substance use is lower among ethnic minorities, particularly among immigrants from South Asia (UKDPC, 2010).

For nutrition, the protective effect of a Mediterranean diet is often emphasised (Powles, 1990; Kouris-Blazos, 2002; Knoops et al., 2004); South Asian diets can have harmful dietary fat content due to use of oils, ghee and butter (Bhopal and Rafnsson, 2009). For Eastern Europeans, intake of saturated fat, sugar and complex carbohydrates are cited as causes for concern (Boylan et al., 2009). Obesity varies by ethnic background with low relative levels among Bangladeshi and Indian men and the Chinese, and higher relative levels among Black Caribbean, Black African and Pakistani women (Higgins and Dale, 2010). Chinese, Pakistani, Bangladeshi and Indian men all report low relative levels of physical activity relative to UK-born.

Previous research thus shows extensive variation in immigrant health profiles; immigrants in England and Wales practice both healthy and unhealthy behaviours. We can characterise South Asians' health behaviour profiles by low levels of drinking and drug use, with high-fat diets and physical inactivity. Similarly, we can characterise Western Europeans by comparable smoking and drinking rates with a low-fat, protective Mediterranean diet (for some countries). For Indians, Pakistanis and Bangladeshis, low alcohol and cigarette use may be crucial to the migrant mortality advantage. Alternatively, for Western Europeans, diet may play a key role. Cause-specific analysis, alongside the analysis of group-specific health behaviours would give more definitive answers. Unhealthy behaviours among Eastern Europeans, combined with their high relative mortality risk from the country of origin may explain why this group does not have low relative mortality, even if they might be healthier than non-migrants in Eastern Europe.

Health profiles can change over time as immigrants adopt a western lifestyle and no longer practice culture-specific behaviours (e.g. consumption of a British high-fat diet can become common among South Asians (Bhopal and Rafnsson, 2009)). This acculturation may explain the interactions. All groups are converging towards the baseline level, but South Asian and Chinese/Other Asian groups still have low relative mortality at old ages. Alternatively, we may observe a selection effect whereby selection is much greater for younger immigrants. However, given the dominant immigration pattern to England and Wales (migration of young people between 20-30 years old) combined with the unchanging age profile of immigrant groups over time in our sample, this is unlikely. Results could also be a salmon bias effect. If older migrants are more likely to return home through illness/ a desire to die at home but do not record an exit, correcting for denominator bias may diminish the mortality advantage among older migrants. However, the age distribution for those 'lost to follow-up' across countries is not negatively skewed.

We find immigrants from Scotland, Northern Ireland and the Irish Republic have higher mortality than England and Wales-born. The results are consistent with previous literature. Similar patterns have also been observed among Finns migrating to neighbouring Sweden. The culmination of proximity, pre-existing extensive social networks, a shared language, and cultural similarities may significantly ease the migration process and reduce the level of good health required to migrate. While immigrants from these countries may have higher mortality than the host population, previous research has shown that Scottish immigrants may still be healthier than non-immigrants living in Scotland (the country of origin) (Wallace and Kulu, 2014).

Our results are largely consistent with Scott and Timæus (2013) recent study on mortality differentials by ethnicity in England and Wales. We both find low mortality among Indian, Pakistani, Bangladeshi, Chinese and Other Asian immigrants. Findings on all-cause mortality for Scottish and Irish immigrants are also consistent with Wild et al.'s (2007) census study. However, results for international immigrants are only comparable with the early age SMRs (age 20-44); with the study observing the deterioration of most migrant mortality advantages after age 45-years. Our analysis showed declining mortality differences between immigrants and England and Wales-born with age, but most immigrants still had lower mortality at older ages.

The study has several limitations. First, we compare immigrant mortality only to the majority population in the host country (not the country of origin). Second, we do not study the health and selectivity of individuals before immigration; the only direct study of selection observed Mexicans from the same sending area before and after migration and could not detect selection (Rubalcava et al., 2008). Nevertheless, the mortality of immigrants in western host countries is an important public health concern (Jayaweera, 2011). The increasing size and diversity of the proportion of the UK population has significant implications for meeting health needs and for planning and delivering effective healthcare services (Jayaweera and Quigley, 2010). The study's strength lies in its comprehensive adjustment for registration uncertainty. Findings from this study provide additional evidence of a migrant mortality advantage among immigrants in western countries and, importantly, show that low mortality among immigrants is an actuality, not a data artefact. Future research should look beyond all-cause mortality into specific causes of death.

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Chapter II builds on Chapter I by investigating the second possible confounding cause of the migrant mortality advantage, health-related remigration. The previous chapter found migrant mortality rates to be robust to registration uncertainty in the timeliness and reporting of moves into and out of England and Wales. Chapter II extends this by studying the health status of migrants who leave England and Wales. If evidence is found of the remigration of immigrants in poor health, this will question the actuality of the migrant mortality advantage by indicating a possible undercount of deaths in immigrant death statistics in England and Wales and the depression of death rates. However, if little or no evidence is observed, the findings from chapter II, combined with those from chapter I will show that the migrant mortality advantage is real and very likely caused by some combination of selection, cultural factors and health transition.

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Chapter II

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Health-related remigration among migrants living in England and Wales: An Analysis using the ONS Longitudinal Study from 1991-2011.

Previous research shows that migrants in many western countries have good health and low mortality. However, it remains unclear whether and how much the remigration of unhealthy individuals explains the migrant mortality advantage. The aim of this study is to investigate whether migrants in poor health are more likely to leave England and Wales than those in good health. We apply discrete-time survival models to nationally representative data from the ONS Longitudinal Study to investigate the likelihood of remigration among 51,468 immigrants by health status. The analysis shows that for most migrant groups, there is no relationship between health and remigration. Among South Asians there is evidence for remigration of individuals with poor health at younger ages (ages 20 to 64), but not at older ages (65+). The study finds little evidence for health-related remigration among most immigrants in England and Wales suggesting that low migrant mortality is reality, very likely the outcome of the healthy migrant effect.

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3.1. Introduction

A "migrant mortality advantage" has been investigated among immigrants in many western countries (Razum et al., 1998; Abraído-Lanza et al, 1999; Anson, 2004; Deboosere and Gadeyne, 2005; Hajat et al., 2010). However, the debate persists about whether the migrant mortality advantage is real, and the result of a "healthy migrant effect", or created by other factors such as remigration. Remigration can over-inflate the denominator in migrant mortality calculations if exits from the host country are not recorded, as immigrants continue to age in host country databases even after they have left the country (Turra and Elo, 2008). Further, if remigration is selective by health and migrants with poor health are more likely to remigrate, then this could depress migrant death rates (Harding and Balarajan, 2002). Deaths will not be recorded in the host country databases despite the fact that migrants may have lived in the host country for decades. Remigration calls into question the size and scale of the migrant mortality advantage.

The aim of this paper is to investigate whether migrants are more likely to leave England and Wales in poor health. While a recent study has found the migrant mortality advantage to persist after adjusting for denominator bias i.e. those who did not report a remigration (to determine the effect that different exit times had on migrant mortality rates) (Wallace and Kulu, 2014b), we know nothing about the health status of immigrants who leave. This study will improve our understanding of the factors which cause a migrant mortality advantage. Further, England and Wales, as with many other western countries, has a growing foreign-born population (14% in 2011) (Smith, 2011). Migrants both contribute to and mitigate population ageing in their host country (Shaw, 2001), and many of those who migrated to England and Wales during the post-war migration era will have reached old ages. It is important to know, for healthcare and service provision, whether migrants in poor health choose to remain in England and Wales or return home.

3.2. Background

3.2.1. The salmon bias and unhealthy remigration effect

Remigration (or return migration) entails a situation where immigrants return to their country of origin, by choice, after a significant period of time abroad (Dustmann and Weiss, 2007). The *salmon bias effect* proposes that immigrants return home to die at older ages, reflecting a cultural desire to die in their place of birth (Turra and Elo, 2008). The immigrants are ill and returning home to die in familiar surroundings in the care of relatives (Razum and Twardella, 2002; Abraído-Lanza et al., 2005). This return migration of severely ill people can lead to an underestimation of mortality among migrants because, if the person dies shortly after leaving the host country their death is not recorded in any of the host country statistics (Kibele et al., 2008) despite the fact that they may have contributed a substantial amount of risk-time in the host country. This leads to numerator bias in calculations, particularly at older ages (Turra and Elo, 2008).

The *unhealthy remigration effect* proposes that less healthy migrants choose to return to the country of origin. These immigrants may be prone to a higher mortality risk based on poorer general health and factors predictive of poor health (Razum et al., 1998). These factors may include failed social integration, dissatisfaction because of recent unemployment and persistent socioeconomic inequalities (Abraído-Lanza et al., 1999). Migrants who leave because of an unhealthy remigration effect may be the "worst of the best" (Constant and Massey, 2003), in that they have the worst health of the migrants who migrate from the country of origin. This selection by poor general health leaves a robust migrant population with good health and low mortality risk (Vandenheede et al., 2015). Therefore, if remigration is selective and less healthy migrants remigrate this could also depress migrant death rates (Harding and Balarajan, 2002). Unlike the salmon bias effect, immigrants leave before becoming seriously ill (Razum et al., 1998).

Critics of these approaches question the motivation and ability of ill migrants to undertake and survive a journey back to the country of origin (Khlat and Darmon, 2003), especially given the good quality and accessibility of healthcare in the host country (Razum et al., 1998), and that migrants often arrive from low-income countries where they have limited access to healthcare (Norredam et al., 2014). Some argue that regardless of migrant status, or the country in which somebody becomes unwell, being ill may be strongly predictive of staying where you are (Norredam et al., 2014). However, in the event of returning home to die, the decision to return may be based solely on the strength of immigrants' remaining cultural and familial ties to the country of origin (Turra and Elo, 2008). That said, if the migrant's family have settled in the host country, this may negate the desire to return home (Arnold et al., 2010; Norredam et al., 2014).

3.2.2. Previous findings

Evidence for health-related remigration (which has largely been conducted in the U.S.) is mixed. A migrant mortality advantage among Mexican immigrants in the U.S. has previously been attributed to a salmon bias effect (Palloni and Arias, 2004). Arenas et al. (2015) found evidence of higher probabilities of remigration of Mexicans in poor health. Riosmena et al. (2013) found some evidence of salmon bias when studying hypertension and self-rated health among Hispanics. Ullmann et al. (2011) compared returnees and non-migrants in Mexico and found worse health among return migrants in relation to obesity, smoking and psychological health. Others confirm the existence of a salmon bias effect, but state it is of too small a magnitude to be the main cause of the migrant mortality advantage (Turra and Elo, 2008). Abraído-Lanza et al., (1999) argue that return migration does not explain the low mortality among Cubans or Puerto Ricans because political conditions in Cuba render the prospect of return migration unappealing and deaths which occur in Puerto Rico are tabulated in the U.S. statistics.

Outside of the U.S., a study of internal migrants in China found that individuals in poor health were more likely to return home (Lu and Qin, 2014). However, no evidence was found for a salmon bias effect among Scottish return migrants from England (Wallace and Kulu, 2014a). In fact, the returnees were in better health than immigrants. In Denmark, a consistent tendency towards fewer remigrations among immigrants who reported a chronic disease compared to immigrants without one has been observed (Norredam et al., 2014). In Germany, Sander (2007) observed that male immigrants living in Germany who reported poor health were significantly less likely to return home than immigrants in good health. Finally, Vandenheede et al. (2015) calculated that to offset the migrant mortality advantage observed among immigrants living in Belgium, the age-standardised mortality ratios among the return migrants would need to be very high (1,362 per 100,000 among the Western and 3,307 per 100,000 among non-western migrants).

3.2.3. Alternative explanations for a migrant mortality advantage

Beyond return migration, other explanations for the migrant mortality advantage include the healthy migrant effect. The *healthy migrant effect* advocates the selection of the healthiest people from the country of origin which creates a uniquely healthy stock of migrants in the host country with good health a low mortality risk (McDonald and Kennedy, 2004). *Cultural factors* include the practice of healthy, culture-specific behaviours which protect health and lower mortality (Abraído-Lanza et al., 1999). A Mediterranean diet among Southern European migrants, for example, has been shown to lower chronic disease incidence, with reductions in cardiovascular diseases (9%) and cancers (6%) (Sofi et al., 2008). The *rapid health transition* *hypothesis* states that non-western immigrants experience low mortality immediately after arrival due to a decrease in mortality from infectious diseases – the main cause of death in the origin country – through access to quality healthcare and better hygiene and environmental conditions. This is combined with only a gradual increase in the increasing importance of chronic diseases (the main causes of deaths in the host country) for their mortality (Spallek et al., 2011).

Finally, registration uncertainty (the other factor which can lead to artificially low mortality rates) posits that earlier reporting of entry dates and non-reporting of exit dates of immigrants can downwardly bias mortality rates through overestimating time-at-risk (Kibele et al., 2008). Registration uncertainty is inherently linked to remigration, but also involves moves unrelated to health. In the UK, Wallace and Kulu (2014b) have recently tested the effect of projecting different entry and exit dates on the size of the mortality advantage using register-based data. For entries, they fitted two models (one allowing migrants to enter on the date specified upon registration with the National Health Service and another limiting entry to first appearance at census). For exits, they fitted three models projecting different exit scenarios (of 2, 4, and 7-years after final census) for those immigrants who did not record an exit from the data. The mortality rates of the migrants in the study were quite robust to these different entry and exit scenarios.

3.3. Data & Methods

3.3.1. The Office for National Statistics Longitudinal Study (LS)

The LS is a continuous multi-cohort study which links census and life event information for a representative 1% sample of the population living in England and Wales. The original sample was selected from the 1971 Census and linked census and life event data on people born on one of four birth dates. Information on individuals has been updated at subsequent censuses in 1981, 1991, 2001 and 2011 and, throughout this time, new members (if they were born on one of the four dates of birth) could enter into the LS by birth, at the time of next census or by registering with the National Health Service (NHS) between census years (Hattersley and Creeser, 1995). Information on life events has been added to the LS since 1971. Life events include new births to sample mothers and immigrations (entries) and deaths and emigrations (exits). Migration data are taken from NHS registration systems; data on births and deaths are taken from the civil registration data. At censuses, data on around 500,000 people is collected and linked to existing records. The LS has amassed data on over 1 million people over forty years.

3.3.2. Remigration in the LS

In the LS, notifications of exits are obtained when people de-register from the NHS (recorded emigrations). Loss to follow-up (unrecorded emigrations) occurs when LS members are not found at censuses and life events are not registered. The LS member can be removed from analysis prior to the census where they last appear, while they are known to be alive and still living in England and Wales (Hattersley, 1999). In this study, remigrations are defined using a combination of recorded exits and loss to follow-up. While the assumption is made that lost to follow-up are unrecorded emigrations, individuals can also be lost if people were still in the country but were not counted or did not respond at census (under enumeration), through inconsistencies in linking information (linkage failure), or moves to Scotland (ONS, 2015a). However, in the first two cases, life events are still likely to be linked to the LS dataset even if their census record has not been linked (Johnson and Blackwell, 2007) and in the case of under enumeration, because the LS samples on birth dates, it is unlikely that there is any systematic bias from the oversampling of areas with high ethnic density or with high non-response at the censuses.

Additionally, Blackwell et al., (2003) argue that very few people notify the NHS if they are leaving the country permanently and that if unrecorded exits are the reason for loss to follow-up, linkage failure rates should vary by the year of entry. This is because migrants who enter earlier in the decade are more likely to have left by the time of the next census than those who enter later. The authors observed that among migrants entering in the five years before census, "not found" rates go down, suggesting that the under-recording of exits is substantial in loss to follow-up. In relation to the reporting of exits, Hattersley (1999) made comparisons between International Passenger Survey data and the Longitudinal Study for the period 1987-1989 and found that emigrations were underrepresented by as much as 75%. Finally, in another study of loss to follow-up in the LS, Platt et al. (2005) suggest that given the strength of the ethnic group effects in their models, many losses to follow-up were likely to be unreported exits from the LS.

However, to address the uncertainty in the mechanisms by which LS members become lost to follow-up, we initially fitted two models. The first used recorded exits only[8]. The second used a combination of lost to follow-up and recorded exits. Patterns in both models were similar in terms of likelihood of exit by age (higher at young and old ages), duration of residence (exit most likely within 5-years after arrival), and health status by country of birth. Figure 3.1 shows the distribution of recorded and unrecorded exits by age for all immigrants and some example groups.

[8] See appendix C Table 10

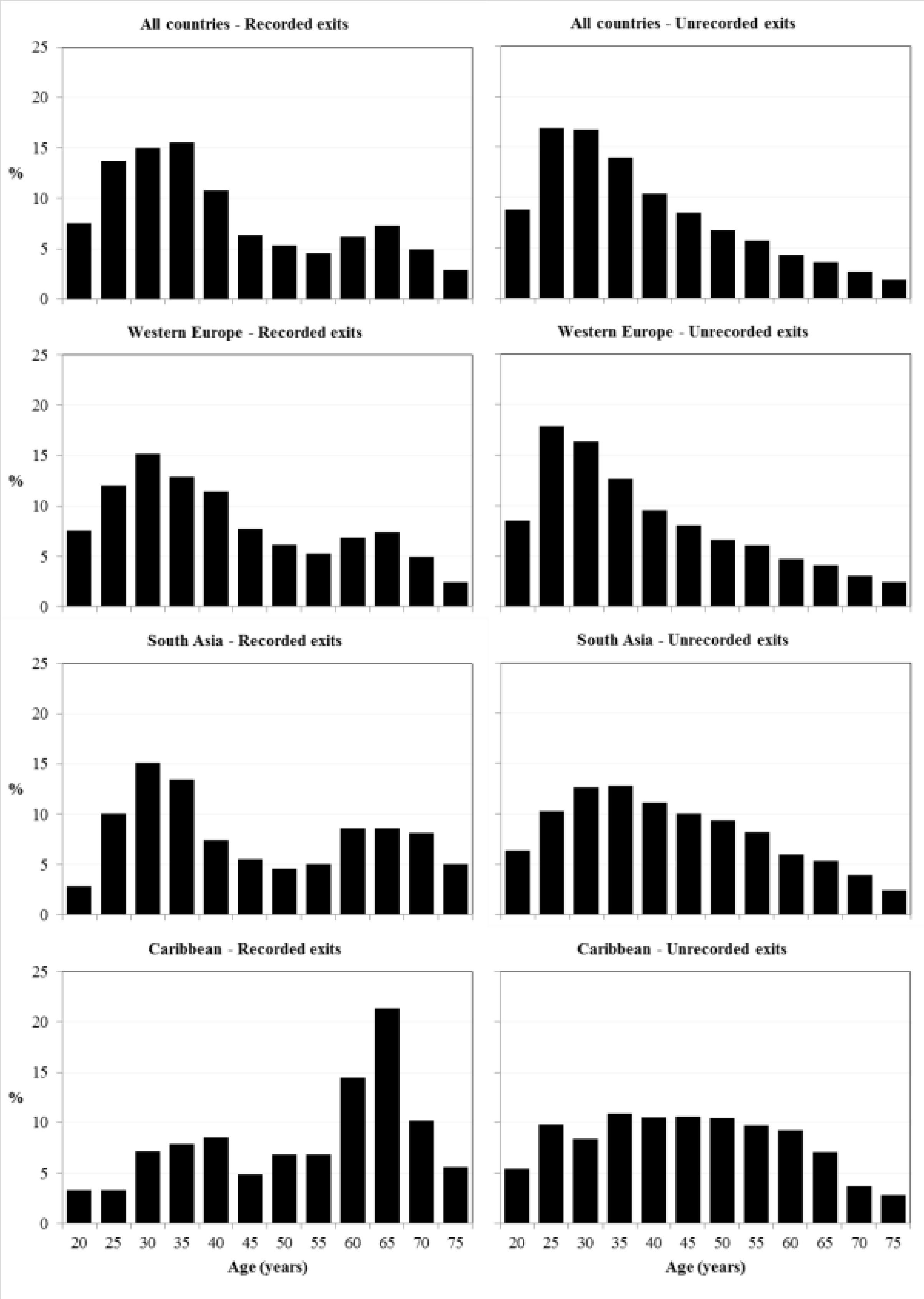

Figure 3.1. distribution of recorded and unrecorded exits by age
Source: author's calculations based on the ONS LS

In figure 3.1, the distribution of both recorded and unrecorded exits for “all migrants” by age is similar in that there is a peak of exits between ages 25 and 35. However, the distribution for recorded exits captures a “mini peak” around retirement age (65). Further, the proportion of unrecorded exits is generally higher between ages 40 and 55. Most groups in the study, like Western Europe, have the same basic shape as “all migrants” for recorded and unrecorded exits. South Asians (Indians, Pakistanis and Bangladeshis) differ in that the mini peak captured by recorded exits is much more pronounced. The standout group however, is the Caribbean. For this group the two peaks are switched. For recorded exits the main peak occurs between ages 60 and 70 with the mini peak between 30 and 40. For unrecorded exits, the proportion is similar between ages 35 and 65. As to why Caribbeans are unique, there is evidence of them returning home to take advantage of the lower cost of living and to get more value from their pensions (which they can receive from the UK) (Byron and Condon, 1996; Harding and Balarajan, 2002).

3.3.3. Limiting long-term illness

Limiting long-term illness (LLTI) is used to measure health status[9]. Whether or not a person has an LLTI is self-assessed. In 1991 the question asked “does the person have any long-term illness, health problem or handicap which limits his/her daily activities or the work he/she can do?” In 2001 it was revised to “do you have any long-term illness, health problem, or disability which limits your daily activities or the work you can do?” The respondents answered ‘yes’ or ‘no’. All ethnic groups reported a higher prevalence of LLTI in 2001 than in 1991, in part as a result of changes to the wording of the question (Smith and Grundy, 2011). While the question relies on an individual’s self-assessment of their own health, LLTI has been found to compare well with all-cause mortality (Bentham et al., 1988; Boyle et al., 2002; Kyffin et al., 2004; Rees et al., 2009) and validation studies from the 1991 census show that it is a good reflection of health status (Thomas and Purdon, 1994). Research using the LS has shown that of those who died between 1991 and 1999, 37% (1 in 3) reported having an LLTI at the 1991 census (Norman, 2002). That said, it also needs to be taken into account that individuals can also die

[9] *A model (Appendix C Table 9) was also run using general health as the health indicator variable (general health is the only other health question asked at census. It was asked for the first time in 2001). Results were very similar to the LLTI models.*

without having reported suffering from a limiting long-term illness (Norman and Bambra, 2007).

3.3.4. Statistical methods

We fit competing-risks, discrete-time survival models (multinomial logistic regression) to study remigration among migrants living in England and Wales and model the likelihood of remigration or death relative to censoring (being alive and living in England and Wales by the end of the study period, which is the 2011 census). It is important, given that our interest is migrants who remigrate in poor health (and in the case of a salmon bias effect are likely to die soon after leaving England and Wales), to model deaths among migrants who stay in England and Wales relative to their health status. While we cannot follow migrants once they have left, modelling mortality among migrants who *stay* in England and Wales will provide us with the risk of mortality between censuses for migrants who report an LLTI relative to those who do not. We can then use this information for remigrants who have left England and Wales having reported an LLTI to make some inferences about their mortality risk. The basic model is as follows:

$$\ln \frac{p(Y_{it}=k)}{p(Y_{it}=K)} = \alpha_t^k + \sum_j \beta_j^k x_{ijt} \qquad (1),$$

where $\boldsymbol{p(Y_{it}=k)}$ is the conditional probability for individual $\boldsymbol{i}$ of moving $\boldsymbol{(k=1)}$ or dying $\boldsymbol{(k=2)}$ during the period of $\boldsymbol{t}$; $\boldsymbol{K=0}$ is a censored episode. $\boldsymbol{\alpha_t}$ is a set of constants to represent the time-dependency of the probability $\boldsymbol{x_{ijt}}$ is the value for individual $\boldsymbol{i}$ of covariate $\boldsymbol{x}$ which may be time-varying, $\boldsymbol{\beta_j}$ is a parameter describing the effect of the covariates. As we lack information on the specific year of migration for most movers we use a discrete-time model with only two crude periods: 1991-2001 and 2001-2011. The hazard is therefore the conditional probability of experiencing either remigration or death in a ten-year period. Our baseline time is period and we have also included other 'clocks': age and duration of residence[10] in the model. Although annual death dates are available for those who died, we use a similar setup for mortality. This is in order to keep consistency across models (except that we exclude duration of residence for death; ideally the effect of the duration of residence on mortality should be analysed using a

[10] *The reader may consider the data as an example of repeated measures data which would require multilevel modelling. We also ran a model with corrected standard errors (for potential clustering – see Appendix C Table 8) and a model with individual-level random effect (which we were able to identify). The results of different specs were nearly identical.*

series of duration-stratified models). Such an analysis is justified given that our interest is in remigration (and that immigrant mortality has previously recently been studied in detail in England and Wales [Scott and Timaeus, 2013; Wallace and Kulu, 2014b; Wallace and Kulu, 2015]).

We adjust for independent variables age (5-year groups), sex, marital status, occupation type, education level, the area of residence type and the duration of residence (see Table 5.1 for categorisations). Education level and occupation type reflect the socioeconomic status of those who leave England and Wales and those who stay. Missing data in occupation type may be a result of failure to answer questions at census, people looking after the family home, people having not had a job in the past ten years or having retired. Marital status and duration of residence reflect the strength of possible social ties in England and Wales. Further, the duration of residence is also adjusted because past research has shown that most remigrations occur in the first 5-years after arrival (Dustmann and Weiss, 2007). The covariates are time-varying at census.

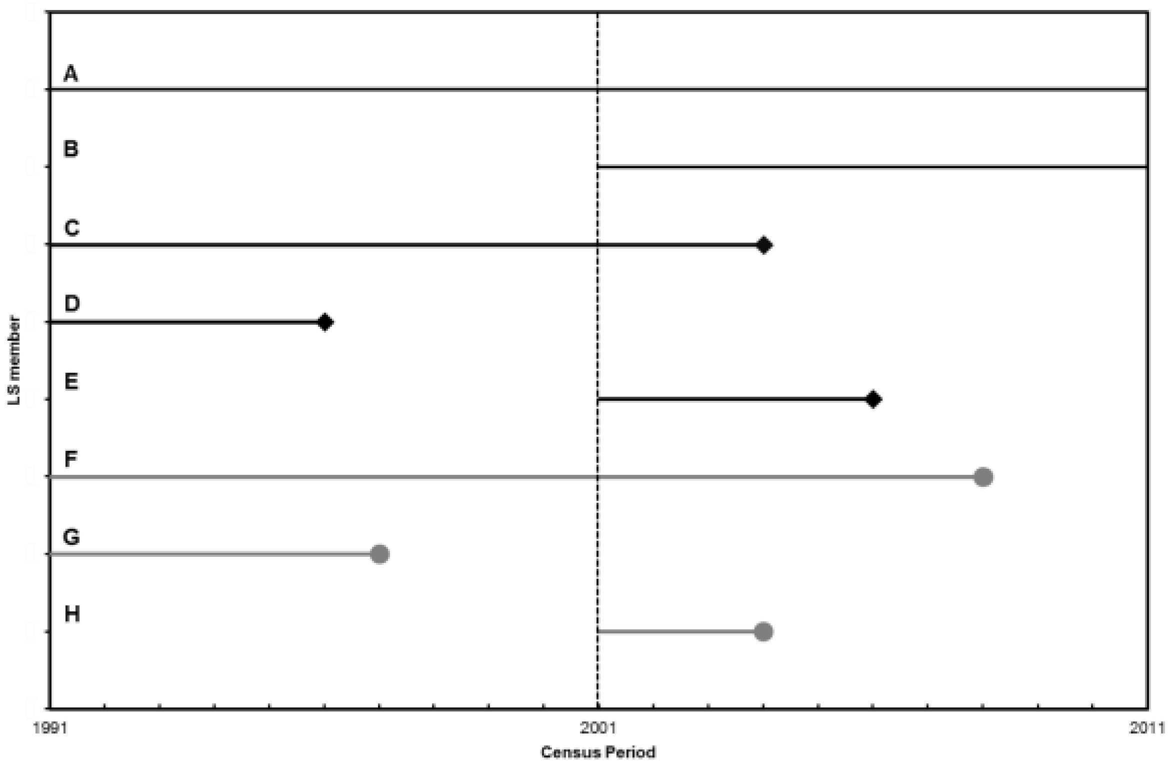

Figure 3.2. Possible life courses of LS members

Fig 3.2 shows all possible life trajectories of LS members based on our multinomial dependant variable. Person **A** is present at the 1991 census and does not remigrate or die during the risk period; they are censored at the census in 2011. Person **B** is observed from the 2001 census (and therefore does not have a record for the first period) and is censored at the 2011 census. Person **C** is observed from the census in 1991 and remigrates between 2001 and 2011. Person **D** is observed from the 1991 census and remigrates between 1991 and 2001 (and therefore has no record for the second period). Person **E** is observed from 2001 and remigrates between 2001 and 2011. Person **F** is observed from the 1991 census and dies between 2001 and 2011. Person **G** is observed from the census in 1991 and dies between 1991 and 2001. Person **H** is observed from the 2001 census and dies between 2001 and 2011. The analysis does not allow people to enter between censuses because we do not have census data for the period in which the person enters.

Table 3.1. LS sample descriptive statistics.

Covariate	Episodes	%	Events			
			Moves	%	Deaths	%
Age (Years)						
20-24	4 666	6,3	1 778	12,9	21	0,3
25-29	6 626	8,9	2 156	15,6	33	0,5
30-34	9 071	12,2	2 123	15,4	48	0,8
35-39	9 199	12,4	1 716	12,4	100	1,6
40-44	8 635	11,6	1 347	9,7	153	2,5
45-49	7 500	10,1	1 135	8,2	196	3,2
50-54	6 660	9,0	898	6,5	282	4,6
55-59	5 331	7,2	767	5,5	372	6,1
60-64	5 011	6,7	679	4,9	605	9,9
65-69	4 292	5,8	507	3,7	895	14,6
70-74	3 036	4,1	381	2,8	951	15,5
75-79	2 299	3,1	221	1,6	1 054	17,2
80-84	1 153	1,6	72	0,5	743	12,1
85+	805	1,1	44	0,3	673	11,0
Period						
1991-2001	33 827	45,5	4 849	35,1	2 911	47,5
2001-2011	40 457	54,5	8 975	64,9	3 215	52,5
Duration of residence (Years)						
0-5	17 649	23,8	7 655	55,4	635	10,4
6-10	9 920	13,4	1 748	12,6	482	7,9
11-15	5 438	7,3	717	5,2	157	2,6
16+	41 277	55,6	3 704	26,8	4 852	79,2
Sex						
Male	35 321	47,5	6 824	49,4	3 291	53,7
Female	38 963	52,5	7 000	50,6	2 835	46,3
Limiting Long-Term Illness						
No	60 435	81,4	12 029	87,0	2 629	42,9
Yes	13 849	18,6	1 795	13,0	3 497	57,1

Covariate	Episodes	%	Events			
			Moves	%	Deaths	%
Country of Birth						
India	13 334	18,0	1 569	11,3	1 183	19,3
Pakistan	7 472	10,1	1 071	7,7	332	5,4
Bangladesh	3 157	4,2	437	3,2	124	2,0
Jamaica	3 085	4,2	507	3,7	354	5,8
Other Caribbean	2 559	3,4	441	3,2	218	3,6
East & South Africa	6 081	8,2	853	6,2	222	3,6
West & Central Africa	2 487	3,3	595	4,3	113	1,8
Western Europe	11 482	15,5	2 197	15,9	1 105	18,0
Eastern Europe	4 303	5,8	625	4,5	1 161	19,0
China	2 012	2,7	487	3,5	119	1,9
Other Asia	4 871	6,6	1 160	8,4	195	3,2
Rest of World	13 441	18,1	3 882	28,1	1 000	16,3
Occupation Type						
Professional/managerial	19 454	26,2	4 140	29,9	673	11,0
Skilled	19 618	26,4	3 295	23,8	891	14,5
Unskilled	13 179	17,7	2 111	15,3	779	12,7
Missing	22 033	29,7	4 278	30,9	3 783	61,8
Educational Level						
Degree level +	15 104	20,3	4 032	29,2	464	7,6
> A-level	5 307	7,1	1 342	9,7	179	2,9
< A-level	53 873	72,5	8 450	61,1	5 483	89,5
Marital Status						
Single	12 651	17,0	4 276	30,9	528	8,6
Married	50 935	68,6	7 997	57,8	3 442	56,2
Widowed	5 701	7,7	991	7,2	490	8,0
Divorced	4 997	6,7	560	4,1	1 666	27,2
Area of Residence Type						
London	29 578	39,8	6 231	45,1	2 108	34,4
Metropolitan	14 481	19,5	2 293	16,6	1 228	20,0
Non-Metropolitan	30 225	40,7	5 300	38,3	2 790	45,5
Total	**74 284**	**100,0**	**13 824**	**100,0**	**6 126**	**100,0**

Notes: 74,284 episodes; 51,468 people; *Source: author's calculations based on ONS LS*

3.3.5. Study sample

We only analyse migrants aged 20-years and older when we can be certain that the individual has taken the decision to leave England and Wales (this may not be the case with children). We acknowledge the possible confounding role of student migration in that international students may move to a country, gain qualifications, and remigrate several years later. To test the impact of including students in the analysis, we fitted a model which excluded individuals less than 30 years-old[11]. This had little effect on the models and the patterns were very similar to the model which included migrants aged 20-years and older. We therefore did not exclude students in order to maximise our sample. We exclude people who are untraced (3,829; <7%) because we cannot match their census data with their life event data. It is unlikely we will ever know their life events. A traced LS member is someone who has been found on the NHS registration systems. The final sample for the study is 51,468 immigrants with 13,824 moves and 6,126 deaths.

3.4. Results

Model 1a (Table 2) adjusts for age (*reference: 45-49 years old*), period (*1991-2001*), duration of residence (*0-5 years*), sex (*male*), long term illness (*no*) and country of birth (*India*)[12] to determine which migrants, by country of birth, are most likely to remigrate. Immigrants from India, Pakistan and Bangladesh and East and South Africa are least likely to remigrate from England and Wales, while migrants from Jamaica, Other Caribbean, Western Europe, China and the Rest of the World are most likely to remigrate. These patterns match the findings of Dustmann and Weiss (2007) in their study of return migration from the United Kingdom. They observe that return migration is much less pronounced among migrants from South Asia and Africa relative to migrants from the EU, the Americas and Australia and New Zealand (latter three groups included in the group Rest of the World in this study). There is a weak, albeit significant relationship (to the 95% level) between remigration and poor health status among migrants.

For ancillary covariates in Model 1a, the youngest immigrants are more likely to remigrate; there is also increased tendency to remigrate at oldest ages. Men are more likely to remigrate

[11] Appendix C Table 11

[12] India is selected as the reference group through merit of being the largest migrant group in England and Wales. We do not analyse non-migrants in England and Wales because their exit from the country would be migrations, not remigrations. Migrations are subject to different selection processes such as the *healthy migrant effect* (the selection of the healthiest individuals from the country of origin). This would conflict with what we want to investigate.

than women. Remigrations are more likely in the second period and many occur within the first five years after entry. This again corroborates previous findings in the UK which show that the largest number of remigrations takes place within the first five years after arrival (Dustmann and Weiss, 2007). For death, as expected, mortality risk increases with age, decreases across periods, and is lower among women. Immigrants from India, Pakistan and Bangladesh, China and the Other Caribbean group have the lowest mortality risks while immigrants from West and Central Eastern Europeans and Rest of the World have higher mortality relative to Indians. Migrants who report having an LLTI are 2.79 times more likely to die than those who do not. We can relate this information back to the use of LLTI as a proxy for mortality in the methods section.

Model 1b (Table 2) further controls for occupation type (*professional/managerial*), education level (< *A-levels*), marital status (*single*) and area of residence type (*non-metropolitan*) to see if patterns observed in model 1a persist after adjusting for socioeconomic characteristics. The likelihood of remigration is attenuated, but patterns remain similar to the previous model. Most importantly, after adjusting for the possible confounding covariates, immigrants are no longer more likely to remigrate if they report having an LLTI. Immigrants with a professional or missing occupation[13] are more likely to remigrate than those with a skilled or unskilled job. Similarly, the highly-educated are more likely to remigrate than lower-educated. Single immigrants have a higher likelihood of remigration more than married, divorced or widowed. Migrants living in London are more likely to leave than those in other or non-metropolitan areas.

Model 2a (Table 3) adjusts for the same covariates as model 1a but interacts country of birth with LLTI to determine whether migrants from specific countries are more likely to remigrate in poor health. The patterns for the covariates are the same as for model 1a (they are not shown in Table 3). Interestingly, the effect of LLTI varies by migrant group. Immigrants from South Asia are all more likely to remigrate if they are in poor health. A similar pattern can be seen among West and Central Africans but confidence intervals overlap with those in good health. The likelihood of Jamaican, Other Caribbean and Eastern European migrants remigrating is similar whether they are in poor health or not. All other groups have odds which suggest they

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[13] *A cross tabulation of occupation type with age shows that the missing group is relatively evenly distributed (but missingness is more likely at young ages 20-39). A cross tabulation of occupation type with education level shows that a disproportionate number of those with a missing value for occupation type have no qualifications above A-level (87%). However, this is also the case for the skilled (80.5%) and unskilled (89.6%) categories in occupation type.*

are less likely to remigrate in poor health (though the results were not significant), indicating that they may choose to remain in England and Wales if they have an LLTI. Model 2b adjusts for occupation type, education level, marital status and area of residence type. This attenuates the likelihood of remigration but again the same patterns persist. For all groups there is a strong relationship between LLTI and mortality. Among South Asians, who have a higher likelihood of remigration in poor health, the odds of mortality with and without an LLTI are: India (1.00 [*no LLTI*] vs 2.54 [*LLTI*]), Pakistan (0.94 vs 2.02) and Bangladesh (0.71 vs 2.33). This suggests that South Asian remigrants who leave England and Wales with an LLTI have higher mortality risks.

Model 3 (Table 4) stratifies analysis into age groups 20-64 and 65+[14] and controls for the same variables as in the previous models. These two age models are fitted because the unhealthy remigration effect proposes that remigration occurs at younger ages based on poor general health, while the salmon bias effect posits that immigrants return home to die at old ages. The models will show whether the health-related remigration among South Asians first observed in model 2 is driven by remigration at specific ages. Further, we can see if any health-related remigration is present in the sub-groups of the other countries. At ages 20-64, immigrants from India, Pakistan and Bangladesh are more likely to remigrate in poor health. It is also relevant to note that we initially ran three age models (20-39, 40-64 and 65+), and the likelihood of remigration in poor health was strongest in the youngest age group. For the final analysis we combined these two groups because of small sample sizes. For all other country groups there was no relationship between remigration and poor health, or they had odds which suggested a lower likelihood of remigration in poor health (significant for Other Asian and Rest of the World).

In the 65+ age models, the likelihood of remigrating in poor health is no longer observed for South Asians. Jamaicans are also less likely to remigrate in poor health, while East and South Africans and Western Europeans are as likely to remigrate whether in good health or bad. For all other groups (Other Caribbean, Eastern Europe, Other Asian, Rest of the World) the trend reverses and likelihood of remigration in poor health increases. However, confidence limits overlap between the good and poor health groups and no statistically significant results are observed.

[14] *The coefficients for period, gender and the time since entry effects remain very similar to model 2b and we do not show these coefficients in the table*

Table 3.2. Odds ratios: remigration by country of birth.

Model 1	[a]						[b]					
	Remigration			Mortality			Remigration			Mortality		
	Log Odds	Sig	95% CI	Log Odds	Sig	95% CI	Log Odds	Sig	95% CI	Log Odds	Sig	95% CI
Age (Years)												
20-24	1,45	***	1,32 - 1,60	0,25	***	0,16 - 0,39	1,06		0,96 - 1,18	0,17	***	0,11 - 0,28
25-29	1,12	**	1,02 - 1,22	0,25	***	0,17 - 0,36	0,93		0,84 - 1,02	0,21	***	0,15 - 0,31
30-34	1,02		0,93 - 1,11	0,23	***	0,17 - 0,32	0,92	*	0,84 - 1,01	0,22	***	0,16 - 0,30
35-39	0,95		0,87 - 1,04	0,44	***	0,35 - 0,57	0,91	**	0,83 - 0,99	0,43	***	0,34 - 0,56
40-44	0,93		0,85 - 1,02	0,69	***	0,56 - 0,86	0,92	*	0,84 - 1,01	0,69	***	0,55 - 0,85
45-49	**1**			**1**			**1**			**1**		
50-54	0,97		0,88 - 1,07	1,47	***	1,22 - 1,77	0,97		0,88 - 1,08	1,47	***	1,22 - 1,77
55-59	1,14	***	1,03 - 1,27	2,26	***	1,89 - 2,71	1,15	***	1,04 - 1,28	2,23	***	1,87 - 2,67
60-64	1,13	**	1,01 - 1,26	3,81	***	3,22 - 4,52	1,15	***	1,03 - 1,29	3,67	***	3,10 - 4,35
65-69	1,03		0,92 - 1,17	7,08	***	6,00 - 8,34	1,05		0,93 - 1,19	6,53	***	5,53 - 7,71
70-74	1,29	***	1,13 - 1,48	13,31	***	11,26 - 15,74	1,30	***	1,14 - 1,50	11,7	***	9,88 - 13,9
75-79	1,17	*	0,99 - 1,38	24,34	***	20,48 - 28,93	1,12		0,94 - 1,33	18,05	***	15,03 - 21,67
80-84	1,12		0,85 - 1,47	49,28	***	40,39 - 60,13	1,07		0,81 - 1,41	35,03	***	28,37 - 43,24
85+	2,36	***	1,62 - 3,45	169,9	***	129,5 - 222,7	2,23	***	1,52 - 3,27	116,8	***	88,18 - 154,7
Period												
1991-2001	**1**			**1**			**1**			**1**		
2001-2011	1,64	***	1,57 - 1,71	0,63	***	0,59 - 0,68	1,54	***	1,48 - 1,61	0,67	***	0,63 - 0,72
Country of Birth												
India	**1**			**1**			**1**			**1**		
Pakistan	0,99		0,90 - 1,08	0,91		0,79 - 1,05	1,03		0,94 - 1,13	0,86	*	0,75 - 1,00
Bangladesh	0,78	***	0,69 - 0,88	0,88		0,71 - 1,08	0,80	***	0,71 - 0,91	0,82	*	0,66 - 1,01
Jamaica	1,86	***	1,66 - 2,10	1,12		0,97 - 1,30	1,65	***	1,47 - 1,86	1,02		0,88 - 1,19
Other Caribbean	1,81	***	1,60 - 2,05	0,97		0,81 - 1,16	1,57	***	1,39 - 1,78	0,93		0,77 - 1,11
East and South Africa	1,01		0,92 - 1,12	1,08		0,92 - 1,27	0,92	*	0,83 - 1,01	1,05		0,89 - 1,24
West and Central Africa	1,45	***	1,30 - 1,63	1,56	***	1,25 - 1,96	1,26	***	1,12 - 1,41	1,54	***	1,22 - 1,93
Western Europe	1,84	***	1,70 - 1,98	1,08		0,97 - 1,20	1,66	***	1,53 - 1,79	1,06		0,96 - 1,18
Eastern Europe	1,31	***	1,17 - 1,46	1,25	***	1,11 - 1,40	1,18	***	1,05 - 1,32	1,20	***	1,07 - 1,35
China	1,79	***	1,58 - 2,03	1,01		0,80 - 1,27	1,67	***	1,47 - 1,90	1,00		0,79 - 1,26
Other Asia	1,51	***	1,38 - 1,66	0,89		0,74 - 1,07	1,35	***	1,23 - 1,48	0,88		0,73 - 1,06
Rest of the World	2,04	***	1,90 - 2,18	1,17	***	1,05 - 1,30	1,81	***	1,68 - 1,94	1,15	**	1,02 - 1,28
Gender												
Male	**1**			**1**			**1**			**1**		
Female	0,82	***	0,78 - 0,85	0,59	***	0,56 - 0,63	0,81	***	0,78 - 0,85	0,53	***	0,49 - 0,57
LLTI												
No	**1**			**1**			**1**			**1**		
Yes	1,07	**	1,01 - 1,14	2,79	***	2,60 - 2,98	1,05		0,98 - 1,12	2,60	***	2,42 - 2,78
Time Since Entry (Years)												
<5	**1**						**1**					
6-10	0,31	***	0,29 - 0,33				0,31	***	0,29 - 0,33			
11-15	0,26	***	0,23 - 0,28	*(Time since entry constrained for death)*			0,26	***	0,24 - 0,28	*(Time since entry constrained for death)*		
16+	0,15	***	0,14 - 0,16				0,15	***	0,15 - 0,16			
Occupation Type												
Professional/Managerial							**1**			**1**		
Skilled							0,89	***	0,84 - 0,95	0,99		0,88 - 1,12
Unskilled							0,90	***	0,84 - 0,97	1,08		0,96 - 1,23
Missing							1,10	***	1,04 - 1,18	1,40	***	1,25 - 1,58
Education Level												
< A-level							**1**			**1**		
Degree level +							1,21	***	1,14 - 1,28	0,84	***	0,74 - 0,94
> A-level	*(Not adjusted for socioeconomic characteristics)*						1,17	***	1,08 - 1,26	0,85	*	0,72 - 1,01
Marital Status												
Single							**1**			**1**		
Married							0,61	***	0,58 - 0,65	0,64	***	0,56 - 0,72
Divorced							0,71	***	0,65 - 0,78	0,82	***	0,70 - 0,96
Widowed							0,66	***	0,59 - 0,75	0,81	***	0,70 - 0,94
Area of Residence Type												
Non-metropolitan							**1**			**1**		
London							1,07	***	1,02 - 1,12	0,92	**	0,85 - 0,99
Metropolitan							1,01		0,95 - 1,08	0,97		0,89 - 1,06

Source: author's calculations based on ONS LS

Table 3.3. Odds ratios: remigration by country of birth and health status.

Model 2	**[a]**								**[b]**							
	Remigration				Mortality				Remigration				Mortality			
	Log Odds	Sig	95% CI		Log Odds	Sig	95% CI		Log Odds	Sig	95% CI		Log Odds	Sig	95% CI	
Country of Birth by LLTI																
India	**1**				**1**				**1**				**1**			
India (llti)	1,56	***	1,36	1,78	2,75	***	2,39	3,18	1,49	***	1,30	1,71	2,54	***	2,20	2,94
Pakistan	1,00		0,91 -	1,11	0,99		0,81 -	1,22	1,05		0,95 -	1,16	0,94		0,76 -	1,15
Pakistan (llti)	1,46	***	1,24 -	1,72	2,29	***	1,87 -	2,80	1,42	***	1,21 -	1,68	2,02	***	1,65 -	2,48
Bangladesh	0,74	***	0,64 -	1,18	0,78		0,55 -	1,09	0,76	***	0,66 -	0,88	0,71	**	0,50 -	0,99
Bangladesh (llti)	1,46	***	1,17 -	1,82	2,68	***	2,05 -	3,50	1,39	***	1,11 -	1,73	2,33	***	1,78 -	3,05
Jamaica	2,04	***	1,78 -	2,33	1,13		0,92 -	1,39	1,80	***	1,57 -	2,07	1,02		0,83 -	1,26
Jamaica (llti)	2,10	***	1,69 -	2,60	2,97	***	2,42 -	3,64	1,80	***	1,45 -	2,23	2,52	***	2,05 -	3,10
Other Caribbean	1,99	***	1,73 -	2,28	0,90		0,71 -	1,15	1,72	***	1,50 -	1,98	0,85		0,66 -	1,09
Other Caribbean (llti)	1,97	***	1,51 -	2,58	2,77	***	2,14 -	3,58	1,67	***	1,27 -	2,19	2,49	***	1,92 -	3,23
East and South Africa	1,12	**	1,01 -	1,25	1,08		0,87 -	1,35	1,01		0,91 -	1,13	1,08		0,86 -	1,35
East and South Africa (llti)	0,98		0,77 -	1,24	2,78	***	2,17 -	3,56	0,87		0,69 -	1,11	2,44	***	1,91 -	3,14
West and Central Africa	1,54	***	1,37 -	1,74	1,33	*	0,99 -	1,79	1,33	***	1,17 -	1,50	1,33	*	0,98 -	1,79
West and Central Africa (llti)	1,99	***	1,42 -	2,79	5,49	***	3,82 -	7,91	1,72	***	1,23 -	2,42	4,91	***	3,39 -	7,10
Western Europe	2,02	***	1,86 -	2,20	1,05		0,91 -	1,21	1,81	***	1,66 -	1,98	1,02		0,89 -	1,18
Western Europe (llti)	1,86	***	1,59 -	2,18	2,88	***	2,47 -	3,37	1,70	***	1,45 -	2,00	2,69	***	2,30 -	3,15
Eastern Europe	1,44	***	1,27 -	1,63	1,33	***	1,14 -	1,56	1,28	***	1,13 -	1,45	1,26	***	1,08 -	1,48
Eastern Europe (llti)	1,38	***	1,08 -	1,75	3,04	***	2,58 -	3,59	1,25	*	0,98 -	1,59	2,74	***	2,32 -	3,24
China	1,98	***	1,73 -	2,26	0,85		0,62 -	1,17	1,83	***	1,60 -	2,10	0,83		0,60 -	1,14
China (llti)	1,61	**	1,08 -	2,40	3,18	***	2,21 -	4,57	1,55	**	1,04 -	2,32	3,01	***	2,09 -	4,33
Other Asia	1,68	***	1,52 -	1,85	0,84		0,66 -	1,07	1,49	***	1,35 -	1,65	0,83		0,65 -	1,06
Other Asia (llti)	1,27		0,95 -	1,68	2,42	***	1,81 -	3,23	1,10		0,83 -	1,46	2,21	***	1,65 -	2,96
Rest of the World	2,28	***	2,11 -	2,46	1,04		0,90 -	1,21	2,02	***	1,87 -	2,19	1,03		0,88 -	1,20
Rest of the World (llti)	1,70	***	1,46 -	1,98	3,41	***	2,89 -	4,03	1,46	***	1,25 -	1,70	3,06	***	2,59 -	3,62

Note: For model b, period, time since entry, gender, occupation type, education level, marital status and area of residence adjusted for but not shown; *Source: author's calculations based on ONS LS*

Table 3.4. Odds ratios: remigration by country of birth and health status by age.

Model 3	20-64								65+							
	Remigration				Mortality				Remigration				Mortality			
	Log Odds	Sig	95% CI		Log Odds	Sig	95% CI		Log Odds	Sig	95% CI		Log Odds	Sig	95% CI	
Age (Years)																
20-24	**1**				**1**				(Ages 20-64 excluded from model)							
25-29	0,88	***	0,80 -	0,96	1,24		0,71 -	2,16								
30-34	0,88	***	0,80 -	0,96	1,27		0,75 -	2,14								
35-39	0,87	***	0,79 -	0,96	2,48	***	1,52 -	4,04								
40-44	0,87	***	0,79 -	0,97	3,89	***	2,42 -	6,26								
45-49	0,95		0,86 -	1,06	5,64	***	3,52 -	9,05								
50-54	0,93		0,83 -	1,04	8,17	***	5,12 -	13,04								
55-59	1,09		0,97 -	1,23	12,24	***	7,68 -	19,52								
60-64	1,09		0,96 -	1,23	19,94	***	12,54 -	31,70								
65-69	(Ages 65+ excluded from model)								**1**				**1**			
70-74									1,29	***	1,10 -	1,51	1,80	***	1,60 -	2,01
75-79									1,21	*	0,99 -	1,49	2,86	***	2,50 -	3,27
80-84									1,18		0,87 -	1,61	5,60	***	4,72 -	6,65
85+									2,41	***	1,61 -	3,61	18,8	***	14,58 -	24,20
Country of Birth																
India	**1**				**1**				**1**				**1**			
India (llti)	1,40	***	1,19	1,65	2,97	***	2,42	3,66	1,14		0,86	1,51	2,15	***	0,97	2,64
Pakistan	1,06		0,96 -	1,18	1,03		0,81 -	1,32	1,24		0,81 -	1,89	0,78	*	0,14 -	1,15
Pakistan (llti)	1,38	***	1,15 -	1,66	2,38	***	1,83 -	3,09	1,17		0,78 -	1,77	1,60	***	0,79 -	2,21
Bangladesh	0,75	***	0,65 -	0,87	0,69	*	0,46 -	1,03	2,40	***	1,29 -	4,44	1,08	*	0,78 -	2,19
Bangladesh (llti)	1,21		0,94 -	1,55	2,35	***	1,67 -	3,31	2,07	***	1,20 -	3,55	2,69	***	1,46 -	4,31
Jamaica	1,79	***	1,54 -	2,07	1,09		0,82 -	1,45	1,55	**	1,08 -	2,22	0,94		0,26 -	1,29
Jamaica (llti)	1,88	***	1,44 -	2,44	2,58	***	1,89 -	3,54	1,14		0,76 -	1,71	2,26	***	1,10 -	3,00
Other Caribbean	1,82	***	1,58 -	2,11	0,91		0,65 -	1,27	0,97		0,62 -	1,52	0,72		0,04 -	1,04
Other Caribbean (llti)	1,54	***	1,11 -	2,13	2,56	***	1,73 -	3,80	1,37		0,83 -	2,27	2,33	***	1,20 -	3,33
East and South Africa	1,06		0,95 -	1,18	1,09		0,84 -	1,42	0,74		0,41 -	1,33	1,12		0,59 -	1,80
East and South Africa (llti)	0,85		0,65 -	1,10	3,04	***	2,23 -	4,15	0,80		0,45 -	1,45	1,73	***	0,96 -	2,61
West and Central Africa	1,39	***	1,22 -	1,58	1,19		0,83 -	1,70	1,54		0,72 -	3,28	2,09	***	1,35 -	3,87
West and Central Africa (llti)	1,86	***	1,29 -	2,68	5,85	***	3,73 -	9,16	0,86		0,34 -	2,14	3,24	***	1,80 -	6,05
Western Europe	1,92	***	1,75 -	2,10	0,94		0,76 -	1,17	1,10		0,84 -	1,44	0,97		0,18 -	1,19
Western Europe (llti)	1,73	***	1,42 -	2,10	3,19	***	2,47 -	4,10	1,18		0,86 -	1,61	2,26	***	1,03 -	2,79
Eastern Europe	1,50	***	1,31 -	1,72	1,22		0,89 -	1,68	0,60	***	0,42 -	0,84	1,10	***	0,30 -	1,35
Eastern Europe (llti)	1,51	**	1,05 -	2,17	3,54	***	2,46 -	5,10	0,80		0,56 -	1,16	2,35	***	1,06 -	2,90
China	1,90	***	1,65 -	2,18	0,80		0,51 -	1,27	1,29		0,78 -	2,13	0,82		0,27 -	1,31
China (llti)	1,30		0,77 -	2,18	4,65	***	2,72 -	7,96	1,41		0,73 -	2,72	2,27	***	1,30 -	3,66
Other Asia	1,59	***	1,43 -	1,76	0,84		0,61 -	1,16	0,61	*	0,38 -	1,00	0,71		0,04 -	1,04
Other Asia (llti)	1,01		0,72 -	1,41	2,62	***	1,67 -	4,10	1,00		0,58 -	1,73	1,92	***	1,04 -	2,84
Rest of the World	2,19	***	2,02 -	2,38	0,91		0,72 -	1,14	0,70	**	0,52 -	0,96	0,94	**	0,15 -	1,16
Rest of the World (llti)	1,48	***	1,25 -	1,77	3,70	***	2,82 -	4,84	1,07		0,77 -	1,50	2,58	***	1,17 -	3,23
Occupation Type																
Professional/Managerial	**1**				**1**				**1**				**1**			
Skilled	0,90	***	0,85 -	0,96	1,01		0,87 -	1,18	0,93		0,72 -	1,20	0,94		0,78 -	1,14
Unskilled	0,91	***	0,85 -	0,98	1,06		0,90 -	1,26	0,93		0,71 -	1,22	1,07		0,87 -	1,30
Missing	1,14	***	1,07 -	1,22	1,46	***	1,24 -	1,72	1,06		0,83 -	1,34	1,28	***	1,08 -	1,53
Education Level																
< A-level	**1**				**1**				**1**				**1**			
Degree level +	1,21	***	1,14 -	1,29	0,86	*	0,73 -	1,02	1,10		0,87 -	1,40	0,81	***	0,67 -	0,98
> A-level	1,16	***	1,07 -	1,26	0,82		0,65 -	1,05	1,08		0,74 -	1,57	0,91	*	0,70 -	1,18
Marital Status																
Single	**1**				**1**				**1**				**1**			
Married	0,61	***	0,58 -	0,65	0,60	***	0,50 -	0,71	0,80		0,61 -	1,06	0,73	***	0,61 -	0,88
Divorced	0,72	***	0,65 -	0,79	0,83	*	0,66 -	1,03	0,91		0,65 -	1,28	0,85	***	0,67 -	1,08
Widowed	0,68	***	0,58 -	0,80	0,76	**	0,59 -	0,99	0,80		0,59 -	1,07	0,93	***	0,76 -	1,12
Area of Residence Type																
Non-metropolitan	**1**				**1**				**1**				**1**			
London	1,04	*	0,99 -	1,10	0,99		0,89 -	1,11	1,27	***	1,09 -	1,47	0,89	**	0,81 -	0,99
Metropolitan	1,01		0,95 -	1,08	1,05		0,92 -	1,21	1,06		0,88 -	1,28	0,92		0,82 -	1,04

Note: Period, time since entry, gender adjusted for but coefficients not shown

Source: author's calculations based on ONS LS

3.5. Discussion

Our aim was to investigate whether migrants in poor health were more likely to remigrate out of England and Wales. For many of the migrant groups, there was no relationship between remigration and poor health. However, Indians, Pakistanis and Bangladeshis were more likely to remigrate if they had a limiting long-term illness, but the relationship was limited to South Asians in pre-retirement ages. This could be an unhealthy remigration effect in the remigration of South Asians with a below average health status. Moreover, the models showed a higher probability of death among South Asians who remained in England and Wales and reported an LLTI. Based on this pattern we can infer that the mortality risk will be higher among migrants who have remigrated from England and Wales having reported an LLTI. This could indicate some level of numerator bias in the mortality calculations for South Asian migrants. However, for all other migrant groups, the findings do not support a salmon bias or unhealthy remigration effect.

For many of the migrant groups in the study, there was no relationship between likelihood of remigration and poor health. The National Health Service is free at the point of use for all UK residents. Thus if a migrant suffers poor health, it is expected that they would remain in England and Wales to make use of this free healthcare which ranks among the top 20 healthcare systems in the world (Tandon et al., 2001). Even among South Asians (who had a higher likelihood of remigration if in poor health at younger ages), the relatively poor state, quality and cost of the healthcare back in South Asia (Khowaja, 2009; Reddy et al. 2011) questions the likelihood that South Asians would remigrate simply to make use of the healthcare system in the countries of origin.

That said, even if healthcare is free in England and Wales, immigrants can still face significant barriers in a lack of information on how to access health care, language difficulties which limit the ability of providers to diagnose and treat patients, and cultural differences in attitudes to healthcare (Szczepura, 2005; Jayaweera, 2014). However, evidence of healthcare inequality in England and Wales is mixed. Some studies report differences between the negative experiences of South Asians and Chinese patients relative to White and Black patients, which may be a result of language proficiency (and not measurable differences in access to, and quality of, the healthcare) (Lyratzopoulos et al., 2012). However, other studies report at least equal to greater use of services by ethnic minorities (Nazroo et al., 2009). The most recent study suggests that few ethnic inequalities exist in healthcare (Nazroo, 2014). In Germany a study of Turkish return migrants found that, despite German doctors having problems understanding their health issues, many Turks rated healthcare in Germany positively and considered it rational to remain there if they became ill (Razum et al. 2006) – this could be the case for migrants in England and Wales.

Immigrants aged between 20 and 64 from South Asia were more likely to remigrate in poor health. This finding could provide some evidence for an unhealthy remigration effect, where migrants with the worst health of the “best” who left the country of origin remigrate. That this relationship disappears among older South Asian migrants may indicate that the decision to remigrate is easier if the person has fewer social ties to the host country. If were refer back to the results section, we noted that the age models were initially split into three groups. The likelihood of remigration having reported a limiting long-term illness was strongest for the 20 to 39 year-old age group where length of residence in England and Wales is likely to be much shorter. To better test this, we further interacted country of birth with health status and length of residence (simplified to a two category variable [<10 years; >10 years]. For all South Asians living in England and Wales for less than 10 years, there was a strong likelihood (more so than model 2) of remigration for those who reported an LLTI. The groups were almost twice more likely to remigrate having reported an LLTI than without. However, for South Asians living in England and Wales for more than 10 years, there was no relationship between remigration and health.

Many of the older South Asian migrants moved during the post-war labour migration era. After the initial migration of male labour immigrants, the wives and children of male migrants also moved to England and Wales – from India and Pakistan in the 1960s and 1970s and Bangladesh in the 1980s (Coleman 1995, Gardner 2006, Gardner and Shukur 1994). South Asian migrants have long accounted for the largest proportion of migrant spouses in the UK (Charsley, 2011). Therefore, if older South Asians have settled with their families in England and Wales this may negate the desire to return home even if the migrant becomes ill in the host country. For younger South Asians who have weaker social and family ties (having spent less time in England and Wales) the decision to remigrate in if they are in poor health may be more straightforward for them.

Another factor which could influence the decision to remigrate among South Asians is poor language fluency, especially given the strong attenuating effect of duration of residence. Unlike Jamaica, for example, where English is the primary language, English is not the first language in India, Pakistan or Bangladesh (Bauder, 2003). Limited ability to speak the language of the host country has been identified as a possible factor in poor health (Pottie et al., 2008; Ng et al., 2011), linking to negative impacts upon health care, understanding health information and social services (Pottie et al., 2008). Findings from the 2011 census showed that of those whose main language was English or of those proficient in English, 80 and 88 per cent reported good health respectively. Only 65 per cent of people who were not proficient in English reported good health (ONS, 2013). Migrants from South Asia whose English language proficiency is initially poor, and remains poor, may decide to remigrate to South Asia. The 2011 census was the first to include any questions on language in England and Wales. Future research could investigate the relationship between LLTI and language proficiency, particularly among South Asians.

Our study has limitations offering opportunities for further research. First, remigrations can include returns to the country of origin *and* moves to another country. The relationship between health status and remigration to a new country may not be the same as it is with return migration. Second, LLTI is a self-reported measure. While research has shown strong links between LLTI and mortality, people still die without reporting an LLTI (Norman and Bambra, 2007). Third, while we have observed health-related remigration among South Asian migrants of pre-retirement age, we cannot quantify how much this biases mortality rates among these groups. Finally, we over-estimate remigration because we assume that all losses to follow-up in the LS are exits from England and Wales. While research using the LS suggests that loss to follow-up because of unrecorded remigration is quite substantial (Hattersley, 1999, Blackwell et al., 2003, Platt., 2005), individuals can still be lost to follow-up for reasons unrelated to remigration.

We have found little evidence that migrants are more likely to leave England and Wales if they are in poor health, except among Souths Asians of pre-retirement age. Our findings have two implications. First, in relation to the recent study which observed a migrant mortality advantage in England and Wales, the impact of health-related remigration on the size and scale of the migrant mortality advantage will be small and is unlikely to introduce much bias into mortality rates. We can therefore be more confident that migrants benefit from a "healthy migrant effect". Second, most of the migrant groups in this study observed no relationship between remigration and poor health (odds ratios often indicated a lower likelihood of remigration). This suggests that most migrants remain in England and Wales on becoming ill. This will have implications for healthcare and service provision as the migrant population continues to grow and age and may eventually require the adoption of more culturally-sensitive services (Norredam et al., 2014).

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Now that registration uncertainty and health-related remigration have been ruled out as causes of the migrant mortality advantage, chapter III builds on the previous chapters by investigating specific causes of death among immigrants. While all-cause mortality (the outcome of interest in chapter I) is useful to show the main differences between immigrants and the England and Wales-born population, it can mask substantial variation in high or low mortality from specific causes of death. By studying mortality from specific causes, it becomes possible to see which diseases drive the migrant mortality advantage among immigrants living in England and Wales and to see whether low all-cause mortality among any immigrant groups coexists with high mortality from specific causes of death. The analysis of specific causes of death will also help to improve our understanding of the remaining factors which are likely to cause a migrant mortality advantage in the healthy migrant effect, cultural factors and the immigrant health transition.

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Chapter III

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Mortality among Immigrants in England and Wales by Major Causes of Death, 1971-2012: a Longitudinal Analysis of Register-Based Data

Recent research has found a migrant mortality advantage among immigrants relative to the England and Wales-born population. However, while all-cause mortality is useful to show any differences in mortality between immigrants and the host population, it can mask variation in mortality patterns from specific causes of death. This study analyses differences in causes of death among immigrant populations living in England and Wales. We extend previous research by applying competing-risks survival analysis to study a large-scale longitudinal dataset from 1971-2012 to directly compare causes of death. We confirm low all-cause mortality among nearly all immigrants, except immigrants from Scotland, Northern Ireland and the Republic of Ireland (who have high mortality). In most cases, low all-cause mortality among immigrants is driven by lower mortality from chronic diseases (in nearly all populations by lower cancer mortality and in some by lower mortality from cardiovascular diseases (CVD)). This low all-cause mortality often coexists with low respiratory disease mortality and among non-western immigrants, coexists with high mortality from infectious diseases; however, these two causes of death contribute little to overall mortality among immigrants. For men, CVD is the leading cause of death (particularly among South Asians). For women, cancer is the leading cause of death (except among South Asians, for whom CVD is also the leading cause). Differences in CVD mortality over time remain constant between immigrants relative to the England and Wales-born population, but immigrant cancer patterns shows signs of some convergence to the cancer mortality among the England and Wales-born (though cancer mortality is still low by age 80). The study provides the most up-to-date and reliable UK-based analysis of immigrant mortality.[15]

[15] Chapter III is based upon the research paper of the same name published in *Social Science & Medicine 120* (2015) 209-221.

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4.1. Introduction

Recent research has found a migrant mortality advantage among immigrants relative to the White England and Wales-born population which persists after the adjustment for demographic and socioeconomic characteristics and uncertainty surrounding the registration of migration events (Scott and Timaeus, 2013; Wallace and Kulu, 2014b). However, while the analysis of all-cause mortality is useful to show differences between immigrants and the host population, it can mask substantial variation in high or low mortality from specific causes of death. For example, low all-cause mortality among Caribbeans in the UK is driven by low mortality from ischaemic heart disease but coexists with high stroke mortality (Wild and McKeigue, 1997). Analysis of cause-specific mortality will contribute important information on mortality among immigrants in England and Wales and improve our overall understanding of the factors which influence mortality patterns among immigrants. This study will provide the most up-to-date and reliable UK-based analysis of cause-specific mortality patterns among immigrant groups, analysing a long time-series from 1971-2012 using a large-scale, representative longitudinal dataset.

This study investigates the major causes of death (cardiovascular (CVD) diseases, respiratory diseases, cancer, infectious diseases and other causes of death) among immigrants in England and Wales, drawing upon the notion of the immigrant health transition (Spallek et al., 2011), to determine if low all-cause mortality is driven by low mortality, or coexists with high mortality, from specific causes of death. We extend previous research by using large-scale longitudinal data to analyse cause-specific mortality among immigrants. Previous research in the UK has used cross-sectional data (Wild et al., 2006; Wild et al., 2007) and studied certain groups and causes only e.g. South Asians (Balajaran, 1984; Harding et al., 2008). We conduct simultaneous analysis of the causes. Conventional cause-specific analysis facilitates the study of relative mortality by population subgroups separately for each cause of death, but the direct comparison of mortality from different causes is possible only when the causes are analysed together.

4.2. Background

Low mortality among immigrants has previously been found in western countries (Powles, 1990; Khlat and Courbage, 1996; Razum et al., 1998; Abraído-Lanza et al., 1999; McDonald and Kennedy, 2004; Anson, 2004; Hajat et al., 2010), often despite low socioeconomic status relative to the host population (Deboosere and Gadeyne, 2005). Immigrants often have low cancer mortality with site-specific diversity. Non-western immigrants are prone to cancers linked to early life infections (e.g. stomach and liver) and resilient to lifestyle-related cancers (e.g. breast and prostate) (Arnold et al., 2010). Cancer mortality among Moroccans, Turks and Surinamese is low relative to the Dutch (Stirbu et al., 2006). Turks also have low cancer mortality relative to the Belgians, French and Danish and similar cancer mortality to Turkish non-migrants (Spallek et al., 2012). Moroccans living in France have low cancer mortality relative to the French population, men from most cancers and women from breast and intestinal (Khlat and Courbage, 1996). Hispanics have low cancer mortality relative to the U.S. host population (Singh and Siahpush, 2001). A Swedish study observes that immigrant cancer rates are closer to the rates of people in the country of origin than the host country (Hemminki et al., 2002).

CVD mortality varies by country of origin. Finnish, central European and Turkish immigrants in Sweden have high CVD mortality, but Baltics and South Europeans have low mortality (Sundquist and Li, 2006). In the Netherlands, CVD mortality is low among Moroccans, high among Surinamese and similar to the Dutch for Turks (Bos et al., 2004). Among Moroccans in France, men have low CVD mortality but women have high CVD and diabetes mortality (a CVD risk factor) (Khlat and Courbage, 1996). High diabetes mortality is also observed in a study of migrants in several European countries (Vandenheede, 2012). For respiratory diseases, Turks, Moroccans and Surinamese have low mortality relative to the Dutch (Bos et al., 2004). In the U.S., Blacks and Hispanics have low mortality from chronic obstructive pulmonary diseases but not low pneumonia or influenza (Singh and Siahpush, 2001); Asian migrants have high mortality (Singh and Miller, 2004). Studies show high infectious disease mortality among non-western migrants in Europe (Singh and Siahpush, 2001; Bos et al., 2004; Boulogne et al., 2012).

4.2.1. Immigrant health transition

Relative to western host countries, many immigrants arrive from a country in an earlier phase of health transition (Razum, 2006). Upon arrival, immigrants immediately benefit from health care for the treatment of infectious diseases and develop a lower risk due to better hygiene and environmental conditions. Immigrants have also been exposed to fewer chronic disease risk factors, but new ones emerge in smoking, diet and a sedentary lifestyle (Spallek et al., 2011). However, even with the emergence of these new factors, it takes time to acculturate to a western lifestyle (POST, 2007) and behavioural changes, such as increase in smoking prevalence, can predate their effects on mortality levels by decades (Zaman and Mangtani, 2007). Immigrants therefore experience a mortality advantage due to the immediate decrease in risk of death from infectious diseases, combined with only the gradual, growing influence that chronic diseases exert in their mortality (Spallek et al., 2011). Chronic diseases will become the major cause of death and mortality will converge to that of the host population, but only after a lag period (Spallek et al., 2011). Further, immigrants can have high mortality from specific causes of death (but low overall mortality) due to early life exposures in the country of origin or genetic susceptibility and gene-environment interactions (Spallek et al., 2011). Immigrants will move through three different phases of this health transition during the lifecourse; these are outlined below.

4.2.2. Phase I: The period before migration

The first phase, pre-migration, suggests that immigrants are exposed to factors not faced by the majority population in the host country such as deprived and insanitary living conditions (Boulogne et al., 2012) and certain infections (e.g. Helicobacter pylori and hepatitis, which increase risk for stomach and liver cancer) (Spallek et al., 2011). Genetic susceptibility passed down from a parent born in the country of origin influences disease risk through direct causation and gene-environment interactions (Spallek et al., 2011)). South Asians, for example, may be genetically susceptible to certain cardiovascular diseases (Wild and McKeigue, 1997; Gupta et al., 2006); their risk may be enhanced by interaction with the environment (Spallek et al., 2011). Cultural factors such as health-preserving behaviours may also operate to produce lower mortality (Abraído-Lanza et al., 1999). For example, a Mediterranean-style diet among Southern Europeans (Powles, 1990; Khlat and Darmon, 2003; Sofi et al., 2008) has been linked with lower all-cause, CVD and cancer mortality (Knoops et al., 2004) and may offset health-damaging effects of other behavioural risk factors e.g. smoking (Powles, 1990). In the U.S., Latinos have been shown, after adjusting for sociodemographic factors, to drink and smoke less than non-Latino Whites (though they were also less likely to exercise) (Abraído-Lanza et al., 2005).

4.2.3. Phase II: The migration process

During the migration phase, immigrants usually select on the basis of good health (Franzini et al., 2001). The selective effect can be so strong that mortality remains lower than the host population irrespective of socioeconomic status (Deboosere and Gadeyne, 2005) but can vary depending on the motives for migration e.g. education, work or family. Gender differences can exist if men migrate for employment and women for family reunification (Boulogne et al., 2012). Some question the selective effects lasting long enough to explain low mortality among immigrants decades later (Khlat and Darmon, 2003) and the ability of young people to select based on future disease susceptibility (Uitenbroek and Verhoeff, 2002). The only direct study of selection (which compared Mexican immigrants in the U.S. to Mexican non-migrants from the region of origin) could not detect selection effects (Rubalcava et al., 2008). Migration can also be stressful and this might increase the risk for psychiatric diseases or CVD (Spallek et al., 2011).

4.2.4. Phase III: The period after migration

After migration, non-western immigrants can experience a mortality advantage due to the immediate decrease in the risk of mortality from infectious diseases (previously their major cause of death), combined with only a gradual, growing influence of chronic diseases in their mortality (Spallek et al., 2011). Western immigrants can also experience lower mortality if mechanisms such as selection effects, genetics and cultural factors combine to produce low mortality. However, immigrants are then exposed to new risk factors in smoking, diet and a sedentary lifestyle, behaviours largely responsible for chronic diseases (WHO, 2006). While cultural factors may initially dissuade the practice of these behaviours, as the immigrants acculturate and gradually adopt these behaviours (Abraído-Lanza et al., 2005) they amass risk for chronic diseases at a similar rate to the host population. In a large-scale review of the U.S. acculturation literature, Lara et al. (2005), find that in areas such as substance abuse, diet and birth outcomes, acculturation has a negative affect and is associated with poorer health outcomes and health behaviours. In other areas, such as health care use and self-perceptions of health, acculturation can have a positive effect. Franzini et al. (2001) posit that low mortality among immigrants will only persist if immigrants remain culturally distinct from their host population.

Immigrants can also experience poverty after migration (Bhopal et al., 2002) and time spent in poor conditions increases disease risk by a process of accumulation (Spallek et al., 2011). However, evidence of a socioeconomic mortality paradox has been found among Hispanics and Mediterraneans (Khlat and Courbage, 1996; Abraído-Lanza et al., 1999). This may be explained by the rapid health transition, which precedes the gradual, cumulative effect of low socioeconomic status (Spallek et al., 2011). A psychosocial interpretation in the migrant hope effect, suggests that immigrant’s view poor conditions as hardship to be endured and are more sanguine (relative to the host population) in their hope for improvement (Anson, 2004). This outlook may reduce the production of negative emotions that translate into poor health via psycho-neuro-endocrine mechanisms and stress-induced behaviours in smoking (Lynch et al., 2000).

Return migration mechanisms in salmon bias and unhealthy re-migration effect posit that immigrants return home at old ages to die through a cultural desire to die in ones birthplace (Turra and Elo, 2008), or at younger ages based on poorer general health and social factors which may predict a future high mortality risk (Razum et al, 1998). However, the motivation and ability of the ill to undertake a trip home is questioned (Khlat and Darmon, 2003) especially given the high quality of healthcare available to immigrants in the host society (Norredam et al., 2014) and that family has often settled (possibly negating the desire to return) (Arnold et al., 2010). Studies find little evidence of a salmon bias effect (Abraído-Lanza et al., 1999; Rosenberg et al., 1999; Razum et al., 2006). Indeed, recent studies find a decreasing tendency among immigrants with illnesses to return home (Norredam et al., 2014; Wallace and Kulu, 2014a).

In sum, immigrant mortality is determined by factors which operate at different phases of the life course (Spallek et al., 2011). Cause-specific mortality provides us with valuable insight into these factors (Deboosere and Gadeyne, 2005). Before migration, disease patterns reflect patterns in the country of origin, but after migration, patterns will change for diseases for which risk is influenced by exposures in both the country of origin and the host country (Marmot et al., 1984). Based on previous findings and, recalling the aim of the study, we expect that low mortality among immigrants (relative to the English and Welsh host population) will coexist with:

1 *low mortality from cancer and respiratory diseases*

2 *high mortality from infectious diseases*

3 *marked variation by country of birth in cardiovascular disease mortality*

4.3. Data & Methods

We use the Office for National Statistics Longitudinal Study (LS), a nationally representative dataset which links census and life event information for a 1% sample of the population living in England and Wales. We define immigrants by country of birth. Country of birth is asked at each census from 1971 to 2011. For people present at one census we take the country of birth selected at that census; for individuals present at multiple censuses we take the country selected most often. The analysis controls for demographic and socioeconomic characteristics age, sex, period, marital status, occupation type, education level and the area of residence type. The categorisation of these covariates, along with risk-time and death events, is presented in Table 4.1.

In the LS, immigrant entry dates are obtained through their registration with the National Health Service (NHS). People do not have to register immediately and the date of entry specified on the form is not cross-checked and can be inaccurate (Hattersley, 1999). Immigrants can also be picked up at census year if they have not yet registered with the NHS. Immigrant exit dates are recorded through de-registration from the NHS. The NHS advises all patients to cancel their registration if they emigrate. However not all patients do this. If an individual does not notify the NHS of their emigration they will have no exit date and they become 'lost to follow-up' (LTFU). This registration uncertainty could lead to a downward bias in mortality rates (Kibele et al., 2008) if the time-at-risk in the country is overestimated for immigrants. The study therefore implements a framework for controlling registration errors devised by Wallace and Kulu (2014b). They fitted several sensitivity models, allowing immigrants to enter on the date specified with the NHS or limiting entry to first census appearance and projected exit dates for those LTFU of 2-, 4- and 7-years after final census (values based on the empirical distribution of known de-registrations from the NHS). Immigrant mortality was robust to the testing. Wallace and Kulu (2014b) allowed immigrants to enter on the date specified with a doctor and projected a 4-year exit for individuals LTFU, the median value of recorded exit dates.

Mortality from CVD, respiratory, cancers, infectious diseases and other causes of death are studied. The first three groups accounted for seven of ten deaths in the UK in 2014 (cancer 29%, CVD 28%, respiratory 15%) (ONS, 2014). Categorisation of causes is available from the authors. Risk-time and number of death events by all-cause mortality and each cause of death is provided in Table 4.2. We use the underlying cause of death, defined as the disease which initiated the train of morbid events leading directly to death or the accident which produced the injury (WHO, 2015). Wallace and Kulu (2014b) tested the representativeness of mortality in the LS by comparing mortality rates with those of the Human Mortality Database. Mortality at most ages fell within 95% confidence intervals and for all ages fell within 90% confidence intervals.

Table 4.1. Person-years at risk and number of events by covariates.

Covariate	Risk Time	%	Event	%	Covariate	Risk Time	%	Event	%
Age					**Occupation type**				
20-24	1,575,564	11.8	880	1.4	Professional/Managerial	3,239,946	24.2	11,473	18.6
25-29	1,622,355	12.1	965	1.6	Skilled	4,947,606	37.0	20,699	33.6
30-34	1,625,654	12.2	1,260	2.0	Unskilled	2,442,758	18.3	13,426	21.8
35-39	1,598,852	12.0	1,696	2.8	Missing	2,743,820	20.5	15,955	25.9
40-44	1,545,443	11.6	2,655	4.3	**Education Level**				
45-49	1,409,373	10.5	3876	6.3	Degee Level +	1,577,947	11.8	4,460	7.2
50-54	1,177,953	8.8	5165	8.4	> A-level	1,015,308	7.6	2,283	3.7
55-59	957,057	7.2	6,769	11.0	< A-level	10,716,667	80.1	53,834	87.5
60-64	743,603	5.6	8,208	13.3	Missing	64,208	0.5	976	1.6
65-69	524,897	3.9	8,926	14.5	**Marital Status**				
70-74	338,520	2.5	8,723	14.2	Single	4,174,905	31.2	9,309	15.1
75-79	183,898	1.4	7,586	12.3	Married	7,856,936	58.7	38,020	61.8
80-84	66,524	0.5	4417	7.2	Divorced	964,974	7.2	6,533	10.6
85+	4,439	0.0	427	0.7	Widowed	315,330	2.4	6,715	10.9
Period					Missing	61,985	0.5	976	1.6
1971-1981	2,013,172	15.1	3,064	5.0	**Area Type**				
1981-1991	2,930,028	21.9	7,403	12.0	London	1,941,442	14.5	7,375	12.0
1991-2001	3,643,701	27.2	16120	26.2	Other Metropolitan	2,919,884	21.8	14,422	23.4
2001-2012	4,787,229	35.8	34966	56.8	Non-Metropolitan	8,450,000	63.2	38,780	63.0
Gender					Missing	62,804	0.5	976	1.6
Male	6,630,431	49.6	36,266	58.9					
Female	6,743,699	50.4	25,287	41.1	**Total**	**13,374,130**	**100**	**61,553**	**100**

Source: author's calculations based on ONS LS

Table 4.2. Person years at risk and number of events by cause of death.

<table>
<tr><th rowspan="2">Country of Birth</th><th rowspan="2">Risk-Time</th><th rowspan="2">%</th><th colspan="2">All-cause</th><th colspan="2">Cardiovascular</th><th colspan="2">Cancers</th><th colspan="2">Respiratory</th><th colspan="2">Infectious</th><th colspan="2">Other Causes</th></tr>
<tr><th>Events</th><th>%</th><th>Events</th><th>%</th><th>Events</th><th>%</th><th>Events</th><th>%</th><th>Events</th><th>%</th><th>Events</th><th>%</th></tr>
<tr><td>England and Wales</td><td>11,411,341</td><td>85.3</td><td>52,793</td><td>85.8</td><td>16,728</td><td>27.2</td><td>19,984</td><td>32.5</td><td>5,049</td><td>8.2</td><td>468</td><td>0.8</td><td>10,564</td><td>17.2</td></tr>
<tr><td>Scotland</td><td>230,839</td><td>1.7</td><td>1,587</td><td>2.6</td><td>489</td><td>0.8</td><td>573</td><td>0.9</td><td>172</td><td>0.3</td><td>25</td><td>0.0</td><td>328</td><td>0.5</td></tr>
<tr><td>Northern Ireland</td><td>68,736</td><td>0.5</td><td>477</td><td>0.8</td><td>148</td><td>0.2</td><td>174</td><td>0.3</td><td>54</td><td>0.1</td><td><10</td><td>0.0</td><td>97</td><td>0.2</td></tr>
<tr><td>Republic of Ireland</td><td>175,186</td><td>1.3</td><td>1,498</td><td>2.4</td><td>494</td><td>0.8</td><td>572</td><td>0.9</td><td>172</td><td>0.3</td><td>11</td><td>0.0</td><td>249</td><td>0.4</td></tr>
<tr><td>India</td><td>265,944</td><td>2.0</td><td>1,199</td><td>1.9</td><td>560</td><td>0.9</td><td>245</td><td>0.4</td><td rowspan="3">152</td><td rowspan="3">0.2</td><td rowspan="3">53</td><td rowspan="3">0.1</td><td>257</td><td>0.4</td></tr>
<tr><td>Pakistan</td><td>160,716</td><td>1.2</td><td>452</td><td>0.7</td><td>213</td><td>0.3</td><td>119</td><td>0.2</td><td>71</td><td>0.1</td></tr>
<tr><td>Bangladesh</td><td>71,210</td><td>0.5</td><td>183</td><td>0.3</td><td>96</td><td>0.2</td><td>41</td><td>0.1</td><td>27</td><td>0.0</td></tr>
<tr><td>Jamaica</td><td>65,835</td><td>0.5</td><td>475</td><td>0.8</td><td>186</td><td>0.3</td><td>175</td><td>0.3</td><td rowspan="2">48</td><td rowspan="2">0.1</td><td rowspan="2">13</td><td rowspan="2">0.0</td><td>76</td><td>0.1</td></tr>
<tr><td>Other Caribbean</td><td>51,368</td><td>0.4</td><td>249</td><td>0.4</td><td>96</td><td>0.2</td><td>85</td><td>0.1</td><td>45</td><td>0.1</td></tr>
<tr><td>East and Southern Africa</td><td>129,077</td><td>1.0</td><td>295</td><td>0.5</td><td>93</td><td>0.2</td><td>86</td><td>0.1</td><td rowspan="2">28</td><td rowspan="2">0.0</td><td rowspan="2">22</td><td rowspan="2">0.0</td><td>78</td><td>0.1</td></tr>
<tr><td>West and Central Africa</td><td>59,306</td><td>0.4</td><td>150</td><td>0.2</td><td>66</td><td>0.1</td><td>42</td><td>0.1</td><td>30</td><td>0.0</td></tr>
<tr><td>Western Europe</td><td>211,792</td><td>1.6</td><td>785</td><td>1.3</td><td>272</td><td>0.4</td><td>301</td><td>0.5</td><td rowspan="2">77</td><td rowspan="2">0.1</td><td rowspan="2">16</td><td rowspan="2">0.0</td><td>147</td><td>0.2</td></tr>
<tr><td>Eastern Europe</td><td>88,319</td><td>0.7</td><td>426</td><td>0.7</td><td>181</td><td>0.3</td><td>146</td><td>0.2</td><td>71</td><td>0.1</td></tr>
<tr><td>China</td><td>40,268</td><td>0.3</td><td>117</td><td>0.2</td><td>42</td><td>0.1</td><td>43</td><td>0.1</td><td rowspan="2">21</td><td rowspan="2">0.0</td><td rowspan="2"><10</td><td rowspan="2">0.0</td><td>20</td><td>0.0</td></tr>
<tr><td>Other Asia</td><td>94,910</td><td>0.7</td><td>170</td><td>0.3</td><td>55</td><td>0.1</td><td>68</td><td>0.1</td><td>36</td><td>0.1</td></tr>
<tr><td>Rest of the World</td><td>249,283</td><td>1.9</td><td>697</td><td>1.1</td><td>193</td><td>0.3</td><td>236</td><td>0.4</td><td>69</td><td>0.1</td><td>11</td><td>0.0</td><td>188</td><td>0.3</td></tr>
<tr><td>Total</td><td>13,374,130</td><td>100</td><td>61,553</td><td>100</td><td>19,912</td><td>32.3</td><td>22,890</td><td>37.2</td><td>5,842</td><td>9.5</td><td>625</td><td>1.0</td><td>12,284</td><td>20.0</td></tr>
</table>

Notes: For respiratory and infectious diseases, some countries of birth are combined due to low event numbers: South Asian (India, Pakistan and Bangladesh), Caribbean (Jamaica and Caribbean), African (East and South and West and Central Africa), European (West and East) and China (China and Other Asia).[16]

Source: author's calculations based on ONS LS

[16] *Person-years and number of events were also produced separately for men and women. The two tables are available in Appendix D (Tables D5 and D6)*

The study spans three revisions of the International Classifications of Diseases (ICD). Deaths from 1971-1981 relate to ICD-8, 1981-1999 to ICD-9 and deaths from 2000-2012 to ICD-10 (Rooney and Smith, 2000). The change from ICD-8 to ICD-9 is considered a minor revision (Moriyama et al., 2011) but the move to ICD-10 saw changes to the number and structure of chapters and rules for selection of underlying cause of death (Rooney et al., 2002). While bridge coding studies have been conducted to highlight disruptions in the reporting of causes, trying to apply corrections rates would be problematic due to the large number of small population subgroups. To account for this we use the broad disease groups defined above. We also plotted the total number of deaths per year for each disease group for the sample as a whole to check for disruptions in reporting in the years immediately after revisions to the ICD classification. We observed little disruption in the reporting for any of the disease groups between 1971 and 2011.[17]

4.3.1. Study sample

The study period spans 41 years from April 1971 to Dec 2012. At the start of observation in 1971, people aged 20-45 years are studied (or are 'at risk'). As each year passes, the lower age limit remains stationary but the upper age limit increases by one year, each year, up to 86 years in 2012. While age is controlled for (by month) this design (given how critical age structures are for mortality analyses) ensures that age structures of the host population and immigrants remain as comparable as possible. Previous research also suggests that significant numbers of people aged 45-years and older born in India, Pakistan and Bangladesh in 1971 are children born to British expatriates (Marmot et al., 1984). Using the above age design removes these individuals from analysis. People were dropped if it was not possible to match their census and event data (these people are "untraced") (*18,020; <3%*), if we could not assign country of birth (*1,142; <0.2%*), and if dates recorded for peoples' exits and returns to England and Wales were not chronological and we could not determine risk-time (*892; <0.2%*). Final sample is 591,724 people.

4.3.2. Statistical methods

We implement competing-risks survival analysis[18]. The cause-specific hazard function, $\boldsymbol{\mu_k(t)}$, is defined as:

[17] *The number of deaths per year for each disease group is available in Appendix D (Table D11 and Figure D1)*
[18] *Appendix D also presents results from separate cause of death analysis (Tables D12-D21)*

$$\mu_k(t) = \lim_{\Delta t \to 0} \frac{\Pr(t \le T < t + \Delta t, D = k \mid T \ge t}{\Delta t}, k = 1,2\ldots, K, \qquad \textbf{(1)}$$

where ***T*** represents the duration of an episode (or age) and ***D*** denotes cause of death with ***k*** causes. To study mortality among immigrants and the England and Wales-born population by cause of death, we first define a cause-specific proportional hazards regression model, shown below:

$$\ln \mu_k(t) = \ln \mu_{k,0}(t) + \sum_l \beta_{kl} x_l(t) + \gamma_k z, \qquad \textbf{(2)}$$

where $\boldsymbol{\mu_k(t)}$ denotes the hazard (or force) of mortality at age ***t*** and $\boldsymbol{\mu_{k,0}(t)}$ denotes the baseline hazard, i.e. the mortality risk from cause ***k*** by age, which we assume to follow a Gompertz distribution where mortality by age increases exponentially. ***x(t)*** represents the values of a variable measuring individual socioeconomic characteristics; $\boldsymbol{\beta_k}$ is the parameter estimate for ***x(t)***, with ***l*** variables; $\boldsymbol{\gamma_k}$ denotes the effect of variable ***z***, migrant status, on mortality from cause ***k***.

We extend this cause-specific proportional hazards regression model **(2)** to model all causes jointly. This way, we can identify which causes are most important to the overall mortality of the sample:

$$\ln \mu_k(t) = \ln \mu_0(t) + \alpha k + \sum_l \beta_l x_l(t) + \gamma z, \qquad \textbf{(3)}$$

where $\boldsymbol{\alpha}$ denotes the effect of the ***kth*** cause on mortality. The model assumes one baseline for all causes; mortality levels can vary by cause but the effect of socioeconomic and migrant status remains the same.

We then develop a final model where the effect of migration status ***z*** can vary by each cause of death:

$$\ln \mu_k(t) = \ln \mu_0(t) + \sum_l \beta_l x_l(t) + \gamma_k z, \ \textbf{(4)}$$

where $\boldsymbol{\gamma_k}$ is a cause-specific parameter for variable ***z*** (migrant status). The model is very similar to **(2)**, except that it assumes a common baseline for all causes of death and the same effect of socioeconomic characteristics.

The models defined in **(3)** and **(4)** are fitted using extended data, where each person has ***k*** records and ***k*** is the cause of death. We create five datasets (one per cause) as if we were modelling each cause separately (thus in each dataset mortality from the four other causes is treated as censored i.e. death=0), but we define a variable cause which is common to all datasets. In the CVD dataset, cause=1, in the cancer dataset, cause=2 … up to the other cause dataset where cause=5. We append these datasets to create the extended data. For model 1, we model all-cause mortality and specify cause as an explanatory variable like in equation **(3).** For model 2, we interact variable cause with country of birth like in equation **(4)** to simultaneously model cause-specific mortality among immigrants. This approach has become common in mortality research (Putter et al. 2007) but has not been used to study immigrant mortality until now.

4.4. Results

To determine whether immigrants benefit from a migrant mortality advantage, model 1a[19] analyses all-cause mortality and controls for age, period and cause of death. Men and women from India, Bangladesh, Western Europe, Other Asia and Rest of the World have low mortality relative to England and Wales-born (model 1a, Table 4.3). Men from Pakistan and East and South Africa and women from Other Caribbean, West and Central Africa, Eastern Europe and China have low mortality. Women from Jamaica and men and women from Scotland, Northern Ireland and Republic of Ireland have high mortality. All other countries have similar mortality to the England and Wales-born. To determine whether patterns persist beyond differences in socioeconomic status, model 1b (Table 4.3) further controls for occupation type, education level, marital status and the area of residence type (covariates are time-varying and any changes take place at census years 1971, 1981, 1991 and 2001). Nearly all migrants, except for Chinese men and Jamaican women (who have similar mortality to England and Wales-born), have low mortality. The high mortality among men and women from Scotland, Northern Ireland and Republic of Ireland largely persists. For men, CVD and cancer are the leading causes of death, followed by other causes of death, respiratory and infectious diseases. For women, cancer is the leading cause of death, followed by CVD, other causes of death, respiratory and infectious diseases.

Model 2 investigates mortality from specific causes (CVD, cancers, respiratory, infectious, and other causes of death) simultaneously to determine whether all-cause mortality patterns are driven by low mortality, or coexists with high mortality, from specific causes of death among

[19] *Models display hazard ratios, significance levels and 95% confidence intervals. All models from Chapter III are reproduced in Appendix D (Tables D1-D4) and additionally display the log hazard, standard errors, z-scores and values for constant.*

immigrants. Model 2a controls for age and period and model 2b (male: Table 4.4 and Fig. 4.1; female Table 4.5 and Fig. 4.2) further controls for occupation type, education level, marital status and the area of residence type. The simultaneous model imposes one common baseline for all-causes (CVD mortality among England and Wales-born men/women) and assumes the same effect of covariates across causes. Estimates for covariates are not shown in model 2b, but are identical to model 1b. We discuss but do not present, the results from Model 2a to avoid overloading the study with too much information. Model 2a is available in Appendix D (Table D3).

For CVD mortality (2a) marked variation exists by country of origin. Men and women from India have high CVD mortality. Further, men from Bangladesh, West and Central Africa and Eastern Europe, and women from Pakistan and Jamaica, have high CVD mortality. However, men and women from Other Asia and Rest of the World have low CVD mortality. Additionally, men from East and South Africa and Western Europe have low mortality. After adjusting for socioeconomic status (2b) (Table 4.4/5, Fig. 4.1/2), high CVD mortality persists among Indian men but attenuates among Indian women. A polarised pattern emerges among Bangladeshis and Jamaicans. Bangladeshi men have high CVD mortality (CIs overlap with England and Wales-born) and women have low CVD mortality; Jamaican men have low CVD mortality and women high CVD mortality. Among Pakistani women and Eastern European men, initial high CVD mortality attenuates to the CVD mortality level of the White England and Wales-born population. Immigrants from Scotland, Northern Ireland and Republic of Ireland have high initial CVD mortality relative to White England and Wales-born population which persists among women from Republic of Ireland and Scottish men after adjusting for socioeconomic status.

For cancer (2a), mortality among immigrants is generally low relative to cancer mortality among England and Wales-born and there is little (if any) variation by gender. Men and women from India, Pakistan, Bangladesh, East and South Africa, Western Europe, Other Asia, and the Rest of the World have low cancer mortality. Additionally, women from West and Central Africa and Eastern Europe have low cancer mortality. Men and women from Jamaica have similar cancer mortality to England and Wales-born. After adjusting for their socioeconomic status (2b) (Tables 4.4/5 and Fig. 4.1/2), all women have low cancer mortality except for Jamaican (the estimate is indicative of low mortality but CIs overlap with England and Wales-born). Similarly, all men, except Chinese (the estimate is low relative to England and Wales-born but CIs overlap), have low cancer mortality. High cancer mortality persists among immigrants from Scotland and Northern Ireland (except women from Northern Ireland). High cancer mortality attenuates among men/women from Republic of Ireland after socioeconomic control.

For respiratory diseases, due to low event numbers we combine several countries of birth: South Asian (*India, Pakistan and Bangladesh*), Caribbean (*Jamaican and Other Caribbean*), African (*East and South and West and Central African*), European (*Eastern and Western Europe*) and Chinese (*Chinese and Other Asian*). In Model 2a mortality is low among men from South Asia, Caribbean, Africa and Europe and women from Europe and China. All other groups (male and female) have estimates indicative of low mortality but CIs overlap with England and Wales-born. After adjusting socioeconomic status (2b) (Tables 4.4/5, Fig 4.1/2) the same patterns persist among males. Among females, low mortality becomes apparent among Caribbeans and Africans. Immigrants from Scotland, Northern Ireland and Republic of Ireland have high respiratory mortality which persists after adjusting for their socioeconomic status.

Similarly, for infectious diseases death numbers are low and we combine groups in the same way as for respiratory diseases (South Asian, Caribbean, European/Other and Chinese). Men from Scotland, India, Caribbean and Africa have high mortality, while men from Northern Ireland, Republic of Ireland, Europe and China have similar estimates to England and Wales-born. All other males have estimates indicative of high infectious disease mortality but CIs overlap. Women from South Asia and Africa have high mortality; women from Caribbean, China and Rest of the World have similar levels to England and Wales-born. All other women have estimates indicative of high infectious disease mortality but CIs overlap. After adjusting for socioeconomic status (2b) (Tables 4.4/5, Fig. 4.1/2), high infectious disease mortality persists among men and women from Scotland, South Asia and Africa. Estimates for men from Caribbean and the Rest of the World remain high but CIs overlap with England and Wales-born.

For other causes of death (2a), men and women from Western Europe have low mortality relative to the England and Wales-born. Additionally, men from Pakistan, Bangladesh, Other Caribbean and Other Asia have low mortality. Estimates are low for men and women from Eastern Europe and China, men from Jamaica, and women from Pakistan and West and Central Africa but CIs overlap with the England and Wales-born. Estimates are also high among men from Rest of the World and women from Northern Ireland, Republic of Ireland, East and South

Africa and Rest of the World but CIs also overlap with the England and Wales-born. After adjusting for individual socioeconomic characteristics (2b) (Tables 4.4/5, Fig. 4.1/2), low mortality from other causes of death also becomes apparent among men from the Republic of Ireland, Jamaica and Eastern Europe and women from Pakistan, China and Other Asia. High mortality persists among men and women who come from Scotland and men from Northern Ireland.

Table 4.3. Hazard ratios: all-cause mortality among immigrants relative to England and Wales-born.

Model 1	**Male**						**Female**					
	[a]			[b]			[a]			[b]		
	Haz Ratio	Sig	95% CI	Haz Ratio	Sig	95% CI	Haz Ratio	Sig	95% CI	Haz Ratio	Sig	95% CI
Period												
1971-1981	**1**			**1**			**1**			**1**		
1981-1991	0.93	***	0.88 - 0.98	0.92	***	0.87 - 0.97	0.84	***	0.79 - 0.90	0.90	***	0.84 - 0.96
1991-2001	0.86	***	0.82 - 0.91	0.78	***	0.74 - 0.83	0.76	***	0.71 - 0.81	0.83	***	0.77 - 0.88
2001-2012	0.72	***	0.68 - 0.76	0.66	***	0.63 - 0.70	0.66	***	0.62 - 0.71	0.82	***	0.77 - 0.88
Country of Birth												
England and Wales	**1**			**1**			**1**			**1**		
Scotland	1.28	***	1.20 - 1.36	1.28	***	1.20 - 1.36	1.36	***	1.26 - 1.48	1.35	***	1.24 - 1.46
Northern Ireland	1.35	***	1.20 - 1.51	1.21	***	1.08 - 1.36	1.15	*	0.99 - 1.33	1.08		0.93 - 1.25
Republic of Ireland	1.29	***	1.20 - 1.38	0.99		0.92 - 1.06	1.25	***	1.15 - 1.35	1.09	**	1.01 - 1.18
India	0.89	***	0.83 - 0.95	0.83	***	0.78 - 0.90	0.91	**	0.82 - 1.00	0.74	***	0.68 - 0.82
Pakistan	0.73	***	0.65 - 0.82	0.63	***	0.56 - 0.71	0.93		0.80 - 1.09	0.62	***	0.53 - 0.73
Bangladesh	0.89	***	0.75 - 1.05	0.72	***	0.61 - 0.85	0.66	***	0.50 - 0.89	0.41	***	0.30 - 0.54
Jamaica	0.97		0.86 - 1.10	0.66	***	0.58 - 0.74	1.18	**	1.03 - 1.34	0.90		0.78 - 1.03
Other Caribbean	0.88		0.75 - 1.03	0.69	***	0.59 - 0.81	0.82	*	0.67 - 1.01	0.69	***	0.56 - 0.84
East and Southern Africa	0.70	***	0.60 - 0.82	0.67	***	0.57 - 0.78	0.88		0.74 - 1.04	0.74	***	0.62 - 0.87
West and Central Africa	1.00		0.83 - 1.21	0.81	**	0.67 - 0.97	0.64	***	0.46 - 0.88	0.52	***	0.38 - 0.71
Western Europe	0.77	***	0.70 - 0.86	0.72	***	0.65 - 0.80	0.77	***	0.70 - 0.85	0.70	***	0.63 - 0.77
Eastern Europe	0.98		0.86 - 1.10	0.79	**	0.70 - 0.90	0.82	**	0.70 - 0.96	0.74	***	0.63 - 0.86
China	0.87		0.71 - 1.08	0.85		0.69 - 1.05	0.61	***	0.42 - 0.88	0.51	***	0.36 - 0.74
Other Asia	0.57	***	0.47 - 0.71	0.56	***	0.45 - 0.69	0.60	***	0.48 - 0.75	0.54	***	0.43 - 0.67
Rest of the World	0.84	***	0.76 - 0.93	0.80	***	0.73 - 0.89	0.82	***	0.73 - 0.92	0.76	***	0.68 - 0.86
Cause												
Cardiovascular	**1**			**1**			**1**			**1**		
Cancers	0.93	***	0.90 - 0.95	0.92	***	0.90 - 0.95	1.58	***	1.53 - 1.63	1.58	***	1.54 - 1.63
Respiratory	0.25	***	0.24 - 0.26	0.25	***	0.24 - 0.26	0.37	***	0.36 - 0.39	0.37	***	0.36 - 0.39
Infectious	0.03	***	0.02 - 0.03	0.03	***	0.02 - 0.03	0.04	***	0.04 - 0.05	0.04	***	0.04 - 0.05
Other cause	0.57	***	0.55 - 0.58	0.56	***	0.54 - 0.58	0.71	***	0.69 - 0.74	0.71	***	0.69 - 0.74
Occupation Type												
Professional/Managerial				**1**						**1**		
Skilled				1.19	***	1.15 - 1.22				1.03		0.98 - 1.08
Unskilled				1.42	***	1.38 - 1.47				1.35	***	1.29 - 1.41
Missing				2.31	***	2.22 - 2.39				1.90	***	1.82 - 1.98
Education Level												
Degree level				0.67	***	0.64 - 0.70				0.69	***	0.66 - 0.73
> A-level				0.81	***	0.76 - 0.85				0.79	***	0.73 - 0.84
< A-level	*(Not adjusted for*			**1**			*(Not adjusted for*			**1**		
Missing	*socioeconomic*			4.07	***	3.82 - 4.33	*socioeconomic*			5.11	***	4.74 - 5.51
Marital Status	*characteristics)*						*characteristics)*					
Married				**1**						**1**		
Single				1.74	***	1.69 - 1.79				1.69	***	1.62 - 1.77
Divorced				1.44	***	1.39 - 1.49				1.35	***	1.30 - 1.41
Widowed				1.29	***	1.23 - 1.36				1.18	***	1.14 - 1.23
Area of Residence Type												
Non-metropolitan				**1**						**1**		
London				1.08	***	1.04 - 1.12				1.05	**	1.01 - 1.09
Metropolitan				1.15	***	1.12 - 1.17				1.15	***	1.12 - 1.19

Notes: Missing category in marital status and area of residence type omitted from models; significance levels at 1% (***) 5% (**) and 10% (*).

Source: author's calculations based on ONS LS

Table 4.4. Hazard ratios: cause-specific mortality among male immigrants relative to England and Wales-born.

Model 2b (Male)	Cardiovascular			Cancers			Respiratory			Infectious			Other Causes		
	Haz Ratio	Sig	95% CI	Haz Ratio	Sig	95% CI	Haz Ratio	Sig	95% CI	Haz Ratio	Sig	95% CI	Haz Ratio	Sig	95% CI
Country of Birth															
England and Wales	**1**			0.96	***	0.93 - 0.98	0.26	***	0.25 - 0.27	0.02	***	0.02 - 0.03	0.58	***	0.56 - 0.60
Scotland	1.23	***	1.10 - 1.37	1.21	***	1.08 - 1.35	0.35	***	0.29 - 0.43	0.06	***	0.04 - 0.10	0.77	***	0.67 - 0.88
Northern Ireland	1.09		0.89 - 1.34	1.24	**	1.03 - 1.50	0.37	***	0.26 - 0.52	0.01	***	0.00 - 0.08	0.71	**	0.55 - 0.91
Republic of Ireland	1.02		0.91 - 1.15	0.99		0.88 - 1.11	0.32	***	0.26 - 0.39	0.01	***	0.00 - 0.03	0.44	***	0.37 - 0.52
India	1.22	***	1.10 - 1.35	0.40	***	0.33 - 0.47	0.16	***	0.13 - 0.20	0.06	***	0.04 - 0.08	0.50	***	0.43 - 0.58
Pakistan	0.91		0.77 - 1.07	0.43	***	0.34 - 0.55							0.28	***	0.21 - 0.37
Bangladesh	1.19		0.95 - 1.48	0.41	***	0.29 - 0.60							0.21	***	0.12 - 0.35
Jamaica	0.76	***	0.62 - 0.92	0.65	***	0.53 - 0.80	0.11	***	0.07 - 0.16	0.05	***	0.02 - 0.08	0.31	***	0.23 - 0.41
Other Caribbean	0.84		0.66 - 1.07	0.63	***	0.47 - 0.83							0.30	***	0.20 - 0.45
East and Southern Africa	0.71	***	0.55 - 0.91	0.50	***	0.37 - 0.67	0.10	***	0.06 - 0.17	0.08	***	0.04 - 0.15	0.48	***	0.35 - 0.65
West and Central Africa	1.08		0.82 - 1.41	0.59	***	0.41 - 0.85							0.45	***	0.29 - 0.68
Western Europe	0.79	***	0.67 - 0.93	0.69	***	0.58 - 0.82	0.11	***	0.08 - 0.15	0.02	***	0.01 - 0.04	0.43	***	0.35 - 0.54
Eastern Europe	1.02		0.85 - 1.22	0.73	***	0.59 - 0.90							0.37	***	0.27 - 0.49
China	0.87		0.62 - 1.23	0.82		0.57 - 1.17	0.15	***	0.09 - 0.25	0.01	***	0.00 - 0.08	0.46	***	0.29 - 0.75
Other Asia	0.57	***	0.40 - 0.80	0.59	***	0.42 - 0.82							0.32	***	0.20 - 0.51
Rest of the World	0.68	***	0.57 - 0.82	0.69	***	0.58 - 0.83	0.22	***	0.16 - 0.31	0.05	***	0.02 - 0.09	0.62	***	0.51 - 0.75

Notes: Significance levels at 1% (***) 5% (**) and 10% (*); sex, period, occupation type, education level, marital status and area of residence type are adjusted for but not shown, they are identical to Model 1b; For respiratory and infectious diseases, some countries of birth are combined due to low event numbers: South Asian (India, Pakistan and Bangladesh), Caribbean (Jamaica and Caribbean), African (East and South and West and Central Africa), European (West and East) and China (China and Other Asia).

Source: author's calculations based on ONS LS

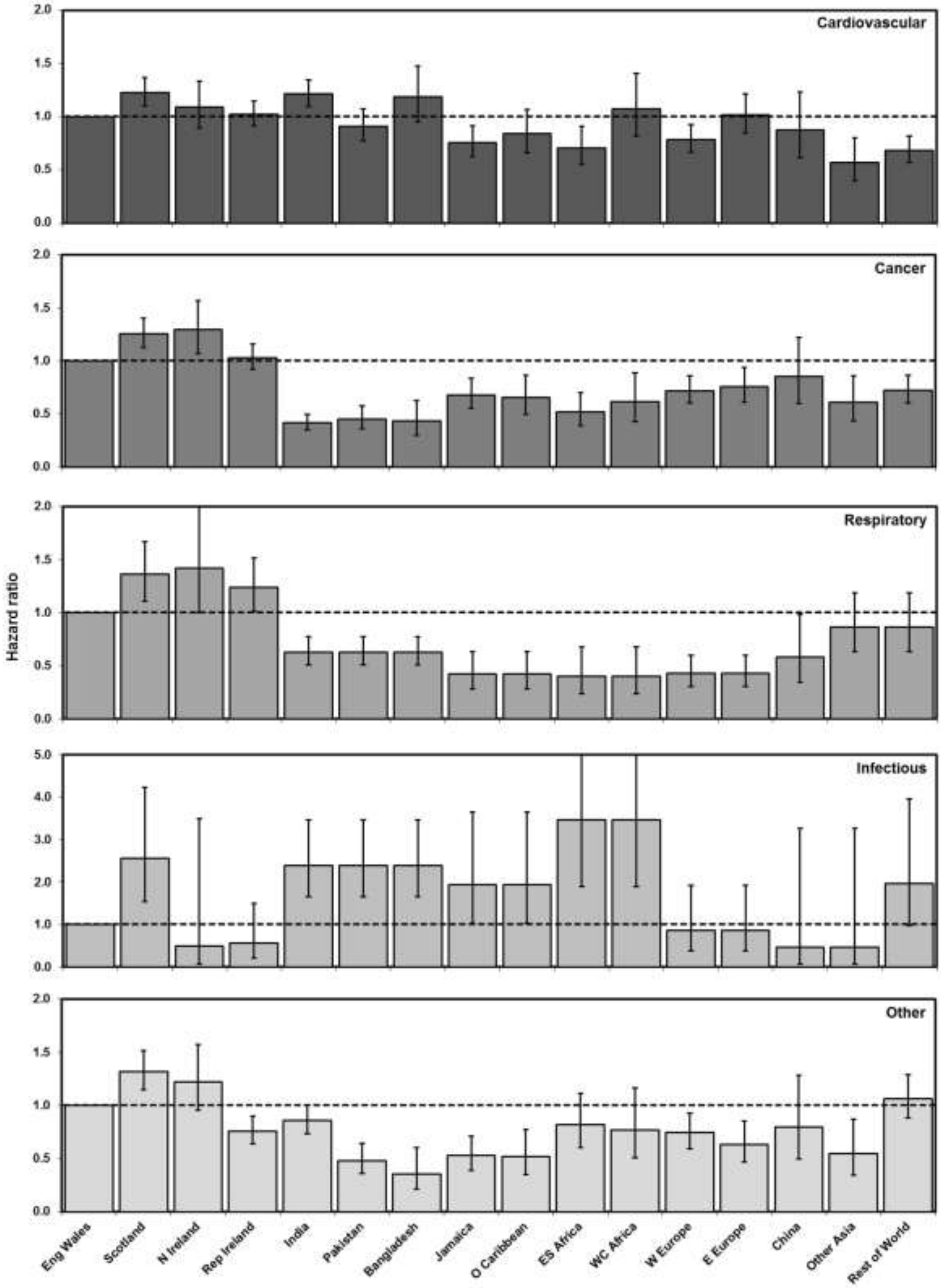

Figure 4.1. Hazard ratios: cause-specific mortality among male immigrants relative to England and Wales-born.

<u>Note:</u> scale of infectious diseases (0-5) is different to the other causes of death (0-2)

Source: author's calculations based on ONS LS

Table 4.5. Hazard ratios: cause-specific mortality among female immigrants relative to England and Wales-born.

Model 2b (Female)	Cardiovascular			Cancers			Respiratory			Infectious			Other Causes		
	Haz Ratio	Sig	95% CI	Haz Ratio	Sig	95% CI	Haz Ratio	Sig	95% CI	Haz Ratio	Sig	95% CI	Haz Ratio	Sig	95% CI
Country of Birth															
England and Wales	**1**			1.65	***	1.59 - 1.70	0.38	***	0.37 - 0.40	0.04	***	0.03 - 0.04	0.73	***	0.70 - 0.76
Scotland	1.32	***	1.13 - 1.55	2.06	***	1.82 - 2.34	0.64	***	0.51 - 0.80	0.07	***	0.04 - 0.14	1.01		0.84 - 1.21
Northern Ireland	1.21		0.92 - 1.59	1.51	***	1.18 - 1.92	0.50	***	0.33 - 0.76	0.07	***	0.02 - 0.21	0.80		0.57 - 1.12
Republic of Ireland	1.16	*	1.00 - 1.34	1.73	***	1.53 - 1.95	0.47	***	0.38 - 0.60	0.04	***	0.02 - 0.09	0.73	***	0.61 - 0.88
India	1.07		0.92 - 1.25	0.76	***	0.63 - 0.91							0.62	***	0.50 - 0.76
Pakistan	0.96		0.75 - 1.22	0.71	**	0.54 - 0.94	0.25	***	0.19 - 0.32	0.09	***	0.06 - 0.13	0.38	***	0.26 - 0.55
Bangladesh	0.54	**	0.33 - 0.88	0.44	***	0.25 - 0.75							0.44	***	0.25 - 0.75
Jamaica	1.26	*	1.01 - 1.57	1.32	**	1.07 - 1.64	0.24	***	0.16 - 0.36	0.03	***	0.01 - 0.09	0.52	***	0.37 - 0.73
Other Caribbean	0.81		0.56 - 1.17	0.98		0.70 - 1.37							0.59	**	0.38 - 0.90
East and Southern Africa	0.67	**	0.48 - 0.95	0.90		0.67 - 1.22	0.21	***	0.12 - 0.35	0.16	***	0.09 - 0.30	0.78		0.56 - 1.08
West and Central Africa	0.67		0.39 - 1.16	0.67		0.39 - 1.16							0.41	**	0.21 - 0.83
Western Europe	0.82	**	0.69 - 0.98	1.12		0.96 - 1.30	0.21	***	0.15 - 0.28	0.05	***	0.03 - 0.09	0.44	***	0.34 - 0.55
Eastern Europe	1.06		0.83 - 1.36	1.04		0.81 - 1.34							0.48	***	0.33 - 0.70
China	0.67		0.36 - 1.25	0.87		0.51 - 1.50	0.13	***	0.06 - 0.27	0.02	***	0.00 - 0.13	0.20	***	0.06 - 0.62
Other Asia	0.58	***	0.38 - 0.87	0.88		0.63 - 1.23							0.45	***	0.28 - 0.72
Rest of the World	0.71	***	0.57 - 0.89	1.10		0.92 - 1.33	0.29	***	0.20 - 0.41	0.03	***	0.01 - 0.09	0.77	**	0.62 - 0.96

Notes: Significance levels at 1% (***) 5% (**) and 10% (*); sex, period, occupation type, education level, marital status and area of residence type are adjusted for but not shown, they are identical to Model 1b; For respiratory and infectious diseases, some countries of birth are combined due to low event numbers: South Asian (India, Pakistan and Bangladesh), Caribbean (Jamaica and Caribbean), African (East and South and West and Central Africa), European (West and East) and China (China and Other Asia).

Source: author's calculations based on ONS LS

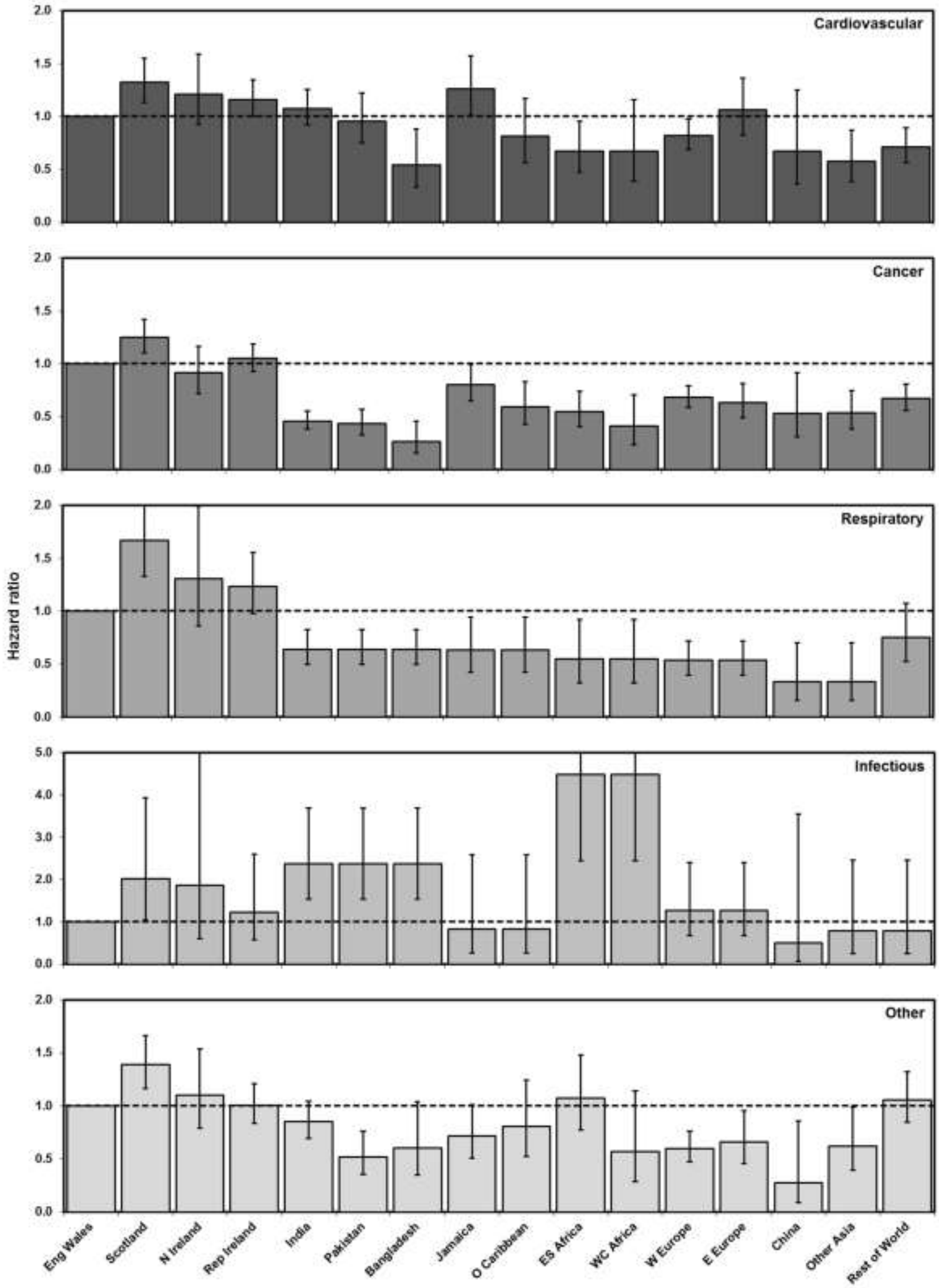

Figure 4.2. Hazard ratios: cause-specific mortality among female immigrants relative to England and Wales-born.

Note: scale of infectious diseases (0-5) is different to the other causes of death (0-2)

Source: author's calculations based on ONS LS

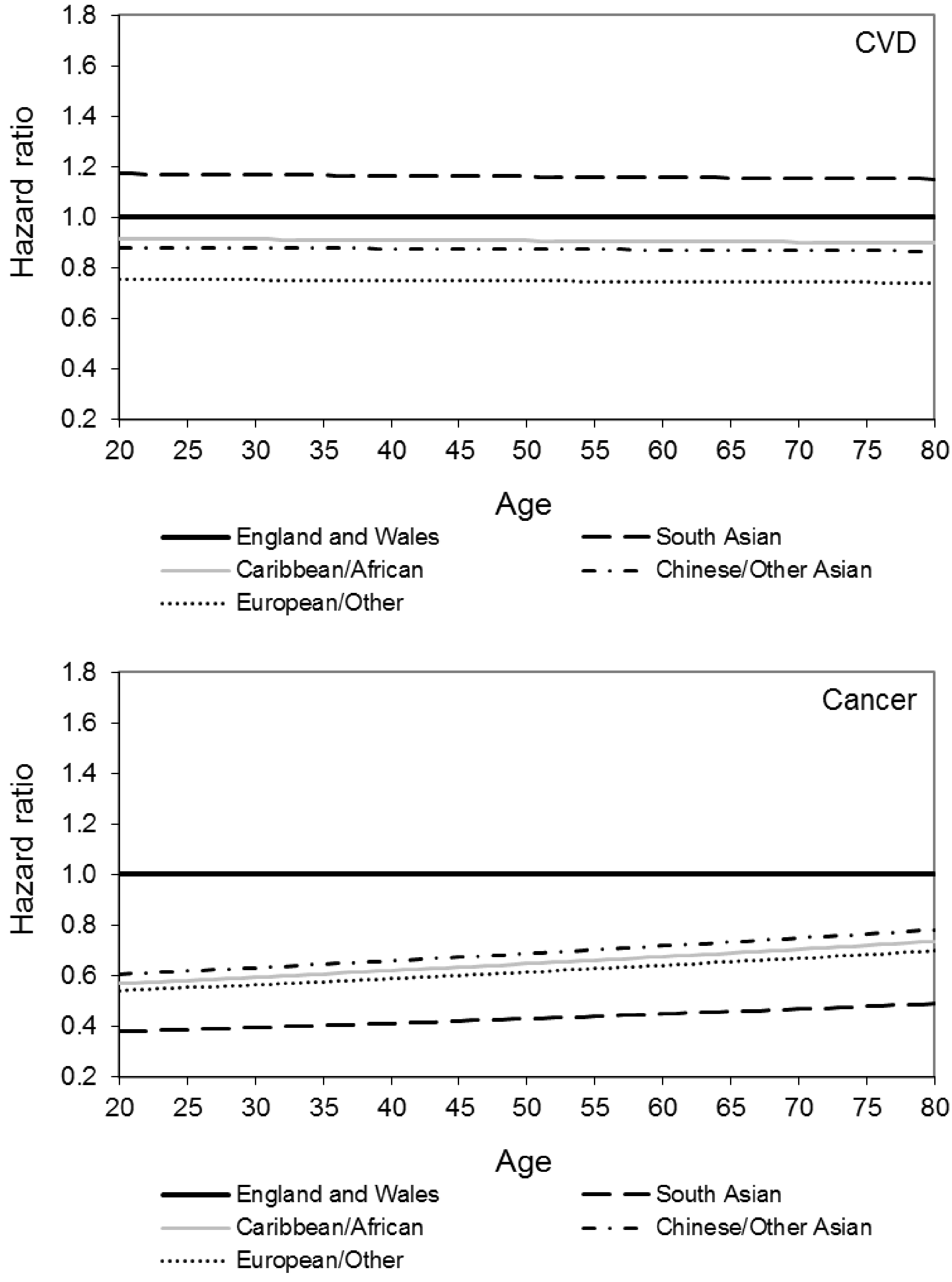

Figure 4.3. Hazard ratios: age interactions among immigrants for CVD and cancer relative to England and Wales-born.

Source: author's calculations based on ONS LS

To assess the importance of this variation in mortality from specific causes of death among immigrants relative to the England and Wales-born, patterns need to be placed in context of the proportion of total mortality each cause of death accounts for. Given that all estimates are relative to just one reference group, we can extract this information by comparing the value of estimates for each cause of death within each country of birth. For men, CVD tends to be the leading cause of death, followed by cancers (Table 4.4). For South Asian men in particular, CVD dominates as their leading cause of death. For Indian men, other causes of death are more important than cancers. CVD also accounts for a large proportion of total mortality among men from West and Central Africa and Eastern Europe. Conversely, for women, cancer is the leading cause in most groups, followed by CVD (Table 4.5). However, for South Asian women, CVD is the leading cause (except for Bangladeshis, for whom the leading cause is other causes). Respiratory and infectious diseases contribute little to the overall mortality of men or women.

Model 3[20] (Fig. 4.3) specifies age as an interaction term (and proxy for length of residence) for the two main chronic disease groups (CVD and cancers) to see if mortality from these two causes becomes more important over time. To fit the models we must aggregate groups to South Asian, Caribbean/African, Chinese/Asian and European/Other. The interaction term is defined as 0= England and Wales-born; 1=immigrants (those from Scotland, Northern Ireland and the Republic of Ireland are coded under 0, but account for less than 4% of the group). We use a likelihood ratio test to the fit of these models. The fit of the CVD model did not improve: LR=0.02, with d.f.=1 and $p>0.1$). As Fig. 4.3 shows, differences in CVD levels by country group relative to England and Wales-born (whether high/low at age 20) remain constant over time. The fit of the cancer model improved significantly: LR=4.46, with d.f.=1 and $p<0.05$). All groups have lower cancer mortality at age 20 relative to England and Wales-born. Fig 4.3 shows that levels do converge but even by age 80-years cancer mortality is still low among immigrants.

4.5. Discussion

The aim of this study was to determine whether low immigrant mortality (relative to the host population) was driven by low mortality, and/or coexisted with high mortality, from specific causes of death. Recalling the hypotheses, we expected low immigrant mortality from cancers and respiratory diseases, high mortality from infectious diseases, and variation by country of

[20] *The models and values for age interactions in CVD and cancer are available in Appendix D (Tables D7-D10)*

origin in CVD mortality. Low all-cause mortality was driven for most immigrants by low mortality from chronic diseases (in nearly all cases from cancer and in some cases from CVD), often coexisted with low respiratory mortality and among non-western immigrants, high mortality from infectious diseases. However, respiratory and infectious diseases contributed little to overall mortality among immigrant populations. For South Asians, low mortality coexisted with high CVD mortality, the leading cause of death among South Asians (except Bangladeshi women). Their low all-cause mortality, despite high CVD mortality, was driven by very low cancer mortality. Immigrants from Scotland, Northern Ireland and the Republic of Ireland had high all-cause mortality which coexisted with high mortality from most causes of death.

These patterns support the notion of the immigrant health transition, which proposes an immediate decrease in the risk of infectious diseases and a gradual transition to increased risk for CVD and cancers (Spallek et al., 2011). For infectious diseases, we have shown that non-western immigrants have high mortality when compared to the White England and Wales-born population. This is due to early life exposures in the country of origin where infectious (not chronic) diseases dominate the epidemiologic regime and people face exposures in deprived and insanitary living conditions (Boulogne et al., 2012). High infectious disease mortality is thus expected. However, this high infectious disease mortality is able to coexist with low overall mortality among immigrants because they immediately benefit from access to better quality health care and fewer die because of infectious diseases (Spallek et al., 2011). The proportion of total mortality accounted for by infectious diseases becomes, as observed, very low.

The immigrant health transition also posits that, on arrival, immigrants have low chronic disease mortality, but this advantage decreases over time (Spallek et al., 2011). We could not control directly for length of residence, but conducted age interactions for CVD and cancer to see if mortality from these chronic diseases exerted more influence over time relative to White England and Wales-born. There was some convergence in cancer but mortality remained lower even at older ages. For CVD, differences remained constant by age. Convergence in cancer provides some support for an immigrant health transition in that immigrants may accumulate risk for cancers over time and this chronic disease becomes more important for their mortality (Spallek et al., 2011). But while cancer showed some convergence it never reached the level of England and Wales-born. Given that immigrants have accumulated few risk factors on arrival, and it takes time to acquire a western lifestyle (POST, 2007), it may be that immigrants never accumulate the same level of risk as England and Wales-born. However, it should also be noted cancer and CVD share common behavioural risks. If acculturation is largely responsible for convergence in cancer mortality, we should have seen some degree of convergence in CVD mortality.

For western immigrants who arrive from countries at a similar stage of health transition, chronic diseases are already the major cause of death in the country of origin. However, if mechanisms such as selection effects do indeed operate to produce low mortality, western immigrants can also benefit from a migrant mortality advantage. Given that we expect gender differences in mortality, our consistent findings across a diverse range of countries, especially for all-cause mortality, may indicate selection effects (Wallace and Kulu, 2014b). Moreover, low mortality from chronic diseases among western immigrants in this study may indicate that individuals with more favourable health behaviours are more likely to migrate. For example, while many Western and Eastern European countries have similar smoking rates to the UK-born (Zatoński et al., 2012), immigrants may select on the basis of having favourable health behaviours (i.e. they do not smoke). For Europeans, a Mediterranean diet, which has been strongly linked with lower all-cause, CVD and cancer mortality, may be quite crucial to low mortality (Knoops et al., 2004) and may offset the health-damaging effects of other risk factors such as smoking (Powles, 1990). Given the lack of evidence for a salmon bias effect in previous studies (Abraído-Lanza et al., 1999; Rosenberg et al., 1999; Razum et al., 2006; Norredam et al., 2014), biases in unrecorded return migrations are unlikely to have an effect on mortality patterns.

Cancer mortality was low among nearly all immigrants. Non-western immigrants are more prone to cancers related to early life infections (e.g. liver, cervical and stomach) and less likely to suffer from cancers related to a western lifestyle (e.g. colorectal, breast and prostate) (Arnold et al., 2010). Immigrant cancer patterns have been shown to remain similar to those in the country of origin (Hemminki and Li, 2002; Spallek et al., 2012) and it has been posited that by moving as adults immigrants have had their cancer incidence environmentally imprinted during the pre-migration phase (Hemminki and Li, 2002). That said, some signs of convergence in the interaction model somewhat challenge this. Breast, prostate, lung and bowel (lifestyle-related cancers) are the leading cancer sites in the UK (Griffiths et al., 2005) and accounted for over half of new cases in 2012 (CRUK, 2015). If the cancer site risk profiles of non-western migrants remain unchanged, continued low mortality from lifestyle-related cancers, which dominate among England and Wales-born, could play a key role in low migrant cancer and all-cause mortality.

High CVD mortality among men from India and Bangladesh, women from Pakistan and India and Jamaican women could be interpreted as the effect of acculturation, reinforced by a gene-environment interaction, which enhances the effect of the health transition (Spallek et al., 2011). Ethnicity (being South Asian/African Caribbean) is an independent risk factor for CVD (NHS, 2012). For South Asians, the thrifty gene and adipose tissue hypotheses posit a gene-environment interaction where individuals develop obesity and CVD risk when exposed to a western lifestyle (Gupta et al., 2006; Sniderman et al., 2007). For South Asians, mortality from CVD could also be so prevalent because there are fewer competing causes of death, especially as cancer rates are so low (Bhopal et al., 2002). Our results show that South Asians have very low rates of cancer mortality, particularly women. Jamaican women (unlike Jamaican men who had low CVD mortality after adjusting for socioeconomic status) had persistent high CVD mortality. Jamaican women, relative to White England and Wales-born women and Jamaican men, are more likely to be obese (Higgins and Dale, 2009; NOO, 2011), have high waist-to-hip ratios and bigger waists (NOO, 2011). Sex-specific acculturation, reinforced by a gene-environment interaction could speed up the health transition among Jamaican women relative to men.

In some cases, high mortality attenuated after adjusting for socioeconomic characteristics. The immigrant health transition posits the effect of socioeconomic characteristics is gradual and cumulative over time. It was not possible to directly adjust for length of residence, but it may be that these immigrants have lived in the UK for longer and accumulated more of the health-degrading effects of socioeconomic status relative to other groups. Moreover, it is generally accepted that chronic disease prevalence and the incidence of risk behaviours is high in more disadvantaged socioeconomic groups (Emmons, 2007). But immigrants do not always conform to the pattern of inequality in the host country and culture-specific attitudes may transcend socioeconomic behaviour patterns e.g. while a strong socioeconomic gradient in smoking incidence is observed in the Chinese, it is weak in Black groups and absent in South Asians (Aspinall and Mitton, 2014). Instances where high mortality attenuated on adjusting for socioeconomic status may also represent acculturation to the adverse behavioural patterns associated with the low socioeconomic circumstances immigrants can experience upon arrival (Bhopal, 2002), intensified by culture-specific attitudes. For example, alcohol intake among Eastern Europeans has been linked to CVD (Britton and McKee, 2000) and is high among men

(Popova et al., 2007). The high CVD mortality observed among Eastern European men (but not women) may reflect culture- and sex-specific health behaviours, which is intensified if Eastern Europeans experience low socioeconomic circumstances after arrival in England and Wales.

Immigrants from Scotland, Northern Ireland and Republic of Ireland had high mortality from each cause of death. Similar to Western and Eastern Europeans, they arrive from countries at a similar stage of health transition to England and Wales, where chronic diseases are the major cause of death. Unlike other western immigrants, other factors such as established migration history, geographical proximity, extensive support networks and a shared language may diminish the scale of the physical and psychological challenges associated with migration and place less emphasis on health as a prerequisite for migration. Recent research corroborates this, showing that Scottish migrants, though they have better health that Scottish non-migrants, are not healthier than the White non-immigrants living in England and Wales (Wallace and Kulu, 2014a).

Our study does have limitations. First, the number of causes we could analyse was restricted by low risk-time and deaths for some causes (e.g. stroke, diabetes) and the number of ICD changes over the study period[21]. Second, analysis of major disease groups may have masked intra-group variation from e.g. specific cancer sites. Diseases of the respiratory system are heterogeneous, comprising acute conditions in pneumonia and chronic conditions such as bronchitis which link to very different exposures and risk factors. Third, we were unable to directly control for length of residence (though we did analyse mortality patterns by age). This would have provided further insight into the immigrant health transition, in terms of low initial mortality which diminishes over time due to the growing importance of chronic diseases. Lastly, we were unable to compare mortality among immigrants to mortality among non-migrants in the country of origin who are arguably a more suitable reference (Rubalcava et al., 2008).

This study has provided the most up-to-date UK-based analysis of immigrant mortality. It is a reliable analysis which has used a long time-series from a large longitudinal sample. We have studied cause-specific mortality among immigrants relative to England and Wales-born and placed patterns in the context of importance of each cause of death for mortality among

[21] *Appendix D displays results for additional causes of death: Ischaemic Heart Disease, Stroke, Diabetes, Other Circulatory, Lung Cancer, Alcohol-related mortality, Accidents and Mental and Behavioural (Tables D22-D29)*

immigrants. Their low mortality was driven by low chronic disease mortality (particularly cancer but in some cases CVD), coexisted with low respiratory mortality and among non-western immigrants, high infectious disease mortality. Low mortality among South Asians was driven by low cancer mortality, but coexisted with high CVD mortality (which was also their leading cause of death). For South Asians, whose CVD mortality may be a result of genetic susceptibility enhanced by gene-environment interactions, interventions to reduce obesity, by promoting good diet and exercise, combined with the adoption of ethnic-specific measures of obesity should be implemented (Gupta et al., 2006). Further research into the mechanisms which underlie low immigrant mortality may provide insight into lifestyle and dietary practices which could help address chronic disease prevalence among the White England and Wales-born.

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Chapter IV builds upon previous chapters by investigating mortality among the descendants of immigrants. The chapter investigates whether low mortality observed among migrants persists (mortality is low relative to White England and Wales-born), attenuates (mortality is similar to White England and Wales-born) or reverses (mortality is high relative to White England and Wales-born) among their descendants. Additionally, Chapter II will provide further evidence for some of the explanations of the migrant mortality advantage. For the "healthy migrant effect" descendants do not move to the host country; therefore if descendants do not have low mortality this could indicate that selection effects in migration operate to produce a migrant mortality advantage. For cultural factors, the descendant's exposures to cultural beliefs and behaviours from the country of origin depend upon immigrant relatives and their degree of acculturation into the host society. Acculturation is said to be crucial for intergenerational changes in health behaviour. If the descendants of immigrants do not have low mortality, this could also indicate that health-related cultural factors are important to the migrant mortality advantage.

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Chapter IV

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Adult mortality among the descendants of immigrants in England and Wales: Does a *migrant mortality advantage* persist beyond the first generation?

Little is known about mortality among descendants of immigrants in western host countries because many descendants have not yet reached ages of high mortality. The aim of this paper is to investigate whether the low mortality recently found among immigrants in England and Wales persists, converges to levels of the White England and Wales-born or reverses among descendants. Survival analysis is used to study mortality among 500,000 individuals in a large, longitudinal dataset (the Office for National Statistics Longitudinal Study). A recent update to this data provides a longer time series with an older sample of descendants to study. The analysis finds that, as a combined group, descendants of immigrants have higher mortality than immigrants and the White England and Wales-born. After adjusting for socio-economic characteristics, mortality among descendants attenuates to mortality among the White England and Wales-born but still remains high relative to immigrants. Analysis by ethnic minority group suggests important differences in mortality among descendants, particularly in the persistent high mortality among the descendants of Black Caribbeans. However, the age structure of descendants is still young and estimates for ethnic minority subgroups may not be robust. We await the further ageing of descendants to confirm or challenge these interesting sub-group findings.[22]

[22] Chapter IV is based upon the research paper of the same name published in the *Journal of Ethnic and Migration Studies (available online).*

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5.1. Introduction

In western host countries, the descendants of immigrants represent a growing share of the population. In 2011, one in five people in England and Wales identified as an ethnic minority (Jivraj and Simpson, 2012). Of these, one in three was born in the UK (Dustmann et al., 2011). Studying mortality among the descendants of immigrants should therefore be of interest. The growing share and diversity of ethnic minorities in terms of their ethnicity, country of birth and socioeconomic status has important implications for their health, healthcare entitlement and access to services (Jayaweera and Quigley, 2010). If policymakers are to effectively plan and deliver services, it is important to learn more about mortality patterns within ethnic minority sub-groups. However, research into mortality among descendants is limited because many have not yet reached ages of higher mortality. A previous UK study has contributed important information on mortality among foreign-born ethnic minorities, but the mortality estimates for UK-born ethnic minorities lacked statistical precision because of their young age structure and low number of deaths (Scott and Timaeus, 2013). Except among Black Caribbean descendants, which Scott and Timaeus (2013) have found to have high mortality, it is unclear whether mortality differences exist between descendants, immigrants and White England and Wales-born.

The aim of this study is to investigate if the low mortality found among immigrants in England and Wales (Scott and Timaeus, 2013; Wallace and Kulu, 2014) persists (descendants also benefit from a migrant mortality advantage), converges to the mortality level among the White England and Wales-born population, or reverses among descendants from the ethnic groups (order largest to smallest): Indian, Pakistani, Black African, Other Asian, Black Caribbean, Bangladeshi, Chinese and Other Black (ONS, 2012). Previous research is extended by using a longer time series of data which, importantly, gives the descendant population more time to grow and reach the ages of higher mortality. The study uses the Office for National Statistics Longitudinal Study (LS), a 1% sample of the population living in England and Wales, which has been recently updated to include 2011 census data and death events to December 2012. Research using this recently updated LS dataset may begin to reveal the nature of mortality changes among descendants of immigrants living in England and Wales (Scott and Timaeus, 2013).

5.2. Background

5.2.1. Ethnic minorities in the UK

The main ethnic groups in the UK are the result of labour migration from the Commonwealth (former colonies in the Caribbean, Indian Subcontinent and Africa), which started after 1945 (Castles et al., 2014). The first to arrive were workers from the Caribbean. People came to work for London Transport and the National Health Service, but many moved simply in response to demand (Peach, 1996; Castles et al., 2014). This arrival of Caribbeans was followed by Indians and Pakistanis, whose migration peaked in the late 1960s and early 1970s (Hannemann and Kulu, 2015). Migration from Kenya also increased from 1961; many were East African Asians (the descendants of immigrants from South Asia) who had initially settled in East Africa during British colonial administration (Smith, 2013). After the Bangladesh war of independence in 1971, immigration from Bangladesh also increased (Smith, 2013). The reunification of families continued from Commonwealth countries until it became restricted from 1971. The migration of Black Africans increased during the 1960s through education, technical training and political instability in parts of Africa (Dustmann et al., 2011). From the 1980s, immigrants from China migrated for, and stayed after, higher education (Dustmann et al., 2011). In 2011, a sizeable per cent of those from Other Black (*68*), Black Caribbean (*60*), Pakistani (*56*), Bangladeshi, Indian (*43*), Black African (*33*) and Chinese and Other Asian (*25*) backgrounds were born in the UK (author's calculations based on Nomis data). The experiences of UK ethnic groups in terms of labour market success, education attainment and life chances have been mixed (Platt, 2005).

5.2.2. Previous empirical findings

Among descendants in other European countries, empirical findings tend to show an intergenerational convergence of mortality rates to the level of the host population among Italian descendants in Switzerland (Tarnutzer and Bopp, 2012), Turkish and Maghrebin descendants in Belgium (after adjusting for educational differences) (De Grande et al., 2014) and Slavics and non-Slavics in Russia (Buckley et al., 2011). However, mortality remains low among the descendants of Turks in Germany (Razum et al., 1998). U.S.-born Hispanics, Blacks, Asians and Pacific Islanders and non-Hispanic whites all have higher mortality than their respective foreign-born groups (though only U.S.-born Blacks have higher mortality relative to the White U.S.-born) (Singh and Siahpush, 2001). When studying mortality among descendants, studies should consider the influence of both migration-related exposures i.e. that certain cultural beliefs and health behaviours may be passed from immigrants to their descendants (Spallek et al., 2011) and context-specific factors in the host country such as geography, interaction with the education system and the labour market and mechanisms of discrimination (Platt et al., 2005).

5.2.3. Selection effects

While immigrants may select for good health through immigration (Franzini et al., 2001), creating a unique and very healthy sample of people from the country of origin, selection plays no role in determining mortality among descendants (Harding and Balajaran, 1996), beyond possible genetic endowment (if genes play a role in the initial selection) (Spallek et al., 2011). Immigrants can also select for traits such as drive, risk-averseness, resilience, ambition and tenacity (Li and Heath, 2007). Descendants do not directly select for these migrant traits but they may be inherited through their immigrant parents. Chinese and Indian educational success in Britain (Heath et al., 2008) and a sense of risk-averseness in the selection of more applied subjects in law, medicine and business among descendants may reflect inheritance of these traits (Boliver 2006). Conversely, Hjern and Allbeck (2002) argue that, because descendants do not migrate, they are less capable of successfully surmounting the challenges of a minority status.

5.2.4. Cultural factors

Descendants can inherit protective cultural beliefs and behaviours from immigrants (Spallek et al., 2011) in, for example, a good diet and cautious attitudes towards alcohol (Markides and Eschbach, 2005); cultural factors are thought to be influential for low mortality among migrants (Abraído-Lanza et al., 1999). However, if immigrants are acculturated into the host society, and no longer practice behaviours from the country of origin, descendants may not inherit the behaviours (Tarnutzer and Bopp, 2012). Their beliefs and behaviours will better reflect those of the western host society (Eitle et al., 2009) which can often be unhealthier (Beiser, 2005). Acculturation is thus crucial for inter-generational changes in behaviours (Spallek et al., 2011). In the UK, smoking rates are high for Black Caribbeans, Bangladeshi men and low for South Asian women. Smoking prevalence is higher for female descendants across all ethnic groups and Black Caribbean/African males (Aspinall and Mitton, 2014). Most ethnic groups observe an inter-generational deterioration in diet (Harding et al., 2008) and increase in alcohol intake (Smith et al, 2009). Typical western behaviours have strong links to chronic diseases (WHO, 2006).

5.2.5. Socioeconomic status

The socioeconomic status of immigrants determines the socioeconomic status of descendants during childhood and this can have an enduring influence in later life (Spallek et al., 2011). Immigrants often experience poverty shortly after migrating to Britain (Bhopal, 2002). If their descendants experience childhood in poverty, social upheaval and adverse living conditions (Hjern and Allbeck, 2002), their mortality may more accurately reflect pathologies associated with poverty (Gans, 1992) in the raised risk for some heart and respiratory diseases (Galobardes et al., 2004). Little signs of inter-generational progress are observed among Black Caribbeans and Africans (Heath and Li, 2008) in the labour market, and Pakistanis and Bangladeshis may be performing worse (Li and Heath, 2010). However, the descendants of Chinese and Indian immigrants have made progress (Heath and Li, 2008; Li and Heath, 2010). In their education, descendants tend to be as qualified as the White England and Wales-born but the possibility of employment remain lower (Dustmann and Theodoropoulos, 2010). Descendants of Indian and Chinese immigrants outperform the host population, but Pakistanis and Black Caribbeans have lower educational attainment (Heath et al., 2008). All ethnic groups are more likely to live in deprived areas than White; Pakistanis and Bangladeshis are three times as likely (Jivraj and Khan, 2013). Ethnic groups with more educated origins (Indian and Chinese) have been shown to reassert their backgrounds over generations after initial downward migration, but those from less-skilled origins (such as Black Caribbeans) are likely to remain less-skilled (Platt et al., 2005).

5.2.6. Psychosocial effects

There may also be psychosocial differences between immigrants and their descendants in the perception of socioeconomic status. Immigrants may benefit from a migrant hope effect where they view their low socioeconomic status as a hardship to be endured in the interest of theirs and their children’s future and are more sanguine in their prospects for improvement (Anson, 2004). Descendants are born in England and Wales and thus have a different frame of reference in White England and Wales-born (Heath and Li, 2008). Descendants then have to confront the frustration of rising expectations in the face of sometimes limited opportunity but are reluctant to work migrant jobs for migrant hours and wages (Gans, 1992). Having been exposed to different wage and consumption standards from the very start, the descendants expect more (Waldinger and Perlmann, 1997). While immigrants may feel that they are doing as well as other ethnic minorities, and better than peers in the country of origin (their frames of reference), their descendants may feel they are doing less well than the White England and Wales-born population. Such perceptions may produce negative emotions that translate into poor health via psycho-neuro-endocrine mechanisms and stress-induced behaviours in smoking (Lynch et al., 2000).

5.2.7. Discrimination

UK studies have shown that experiences of racial harassment and perceptions of employer discrimination are independently related to poor health, independent of socioeconomic effects (Karlsen and Nazroo, 2002; Nazroo, 2003). Karlsen and Nazroo (2014) report a shift in the reporting of racist victimisation in the UK from Caribbeans being most prone in 2000 (than Indians, Pakistanis and Bangladeshis) to individuals from African, Pakistani and Bangladeshi groups by 2009. These instances of discrimination may have a more lasting impact on ethnic minorities who identify as British. In 2011, the per cent of ethnic minority groups identifying as British was: Black Caribbean (*88*), Pakistani (*85*), Bangladeshi (*84*), Black Other (*82*) Indian (*75*), Other Asian (*55*) and Chinese (*54*) (author's own calculations based on Nomis data). The descendants represent an age-specific vulnerability to discrimination (Hjern and Allbeck, 2002) because they can experience it as children (Connolly, 1998). These perceived instances of discrimination may then translate into poor health via the psychosocial mechanisms outlined above.

5.2.8. Healthcare

Finally, in healthcare systems it is acknowledged that ethnic minorities experience barriers to services (Szczepura, 2005). In the UK, one study reports that substantial differences exist in the negative experiences reported by South Asian and Chinese patients (the experience of Black patients was similar to White patients) (Lyratzopoulos et al., 2012). As to why, Lyratzopoulos et al. (2012) suggest that patients may receive very similar standards of health care but have different perceptions of its quality based on language fluency. This may have an ethnic-specific effect in that Black Caribbean immigrants differ from South Asians because their first language is shared with White British (Connolly and White, 2006). Equally, given that descendants often have better language fluency (Heath et al., 2008), there may be an inter-generational effect. Another study reports equal to greater use of primary care services (except for Chinese) and that the outcomes of care are as good for ethnic minorities as for White (Nazroo et al., 2009). Nazroo (2014) later posits that healthcare is unlikely to contribute to any ethnic inequalities in health.

In sum, differences exist in the mechanisms outlined above between immigrants and their descendants which may lead to differences in their mortality risk. First, descendants do not migrate and may thus not select for good health (if good health is a prerequisite of successful migration) or traits associated with immigrants. Second, the cultural beliefs and behaviours of descendants, depending on how acculturated immigrant relatives are, may be more in line with the White England and Wales-born. Third, the childhood socioeconomic circumstances of descendants are inferred by the socioeconomic circumstances of immigrant parents who often experience poverty shortly after their arrival in England and Wales. Fourth, perceptions of socioeconomic status may differ with regards to the frame of reference, expectations and hope for progress and may lead to more marked psychosocial manifestations in descendants. Fifth, healthcare experiences of immigrants and their descendants may differ based on perceptions of care.

Based on past research, which tends to find convergence of descendants' mortality away from lower immigrant mortality towards higher mortality in the host population, and considering how the different causal mechanisms may differently influence mortality among immigrants and their descendants, the following hypotheses are proposed (devised after conducting initial analysis):

1 *Mortality among descendants will converge to higher mortality among White England and Wales-born.*

2 *This convergence in mortality will be accounted for by socioeconomic differences among descendants.*

3 *Mortality variation in mortality is expected across ethnic groups due to their differing socioeconomic circumstances.*

5.3. Data & Methods

The ONS Longitudinal Study (LS) links census and life event information for a 1% sample of the population living in England and Wales. The original sample was selected from the 1971 census, and incorporated data on individuals born on one of four selected dates of birth. The sample has been updated at each successive census by taking individuals with the same four anonymous dates of birth in each year and linking them to existing data. Life event information has been added to the LS since the census in 1971, including birth and immigration (entry events) and death and emigration (exit events) of people with one of the four dates of birth.

Immigration data is taken from National Health Service (NHS) registration systems (people registered with a doctor in England and Wales). Births/deaths are taken from civil registration data.

In the LS, the entry dates of immigrants are obtained through registration with an NHS doctor. Immigrants may register immediately or at any time after entry (the young and healthy are less likely to register); while the date of entry is requested on the application to join a doctor's list, it is not cross-checked and can be wrong (Hattersley, 1999). Individuals can also be picked up at census, if they complete a census form before they register with the NHS (Hattersley and Creeser, 1995). Immigrant exit dates are obtained through de-registration from the NHS. The NHS advises all patients to cancel their NHS registration if they plan to emigrate, but if an individual does not notify the NHS of their emigration they will have no exit date and they become 'lost to follow-up' (LTFU) (Hattersley, 1999). That said, it is possible to identify the decade of exit if the individual is not enumerated at subsequent censuses and does not record any events. They can then be exited from the study prior to the census where they have been found to be missing (Hattersley, 1999). By doing this, the LS member will contribute risk to the denominator only while they are known to be alive and likely still in the country (Hattersley, 1999).

Wallace and Kulu (2014) have previously fitted sensitivity models to test uncertainty in the registration of events on immigrant mortality rates. For entries, they allowed immigrants to enter on the date specified by the individual on their NHS registration form. They then limited the entry of immigrants to their first census. For exits, for those LTFU, they projected exit dates of 2-, 4- and 7-years after final census (dates were chosen based on the empirical distribution of known exits). Immigrant mortality rates were robust to these sensitivity tests. Wallace and Kulu (2014) thus allowed immigrants to enter on the date specified on their NHS form and projected an exit for LTFU at 4-years after final census. This study adopts the same framework. While the assumption is made that people LFTU are unrecorded emigrations, individuals can also be LTFU when incorrect information is recorded. Ultimately, it is not possible to provide definitive answers as to how every individual becomes LTFU in the ONS LS (Blackwell et al., 2003).

Immigrants and their descendants are defined by combing country of birth and ethnicity, which are self-reported at census. For those present at one census, the country of birth and ethnicity reported at that census are used. For people present at multiple censuses, the most frequently specified country of birth/ethnicity are taken. In the case of ties, the earlier country of birth is taken and later ethnicity is taken. Ethnicity is a fluid and changeable concept; unlike country of birth it is not a fixed life characteristic (Simpson et al., 2014). People (particularly from the Black Caribbean and African groups) have been shown to change ethnic group between 1991 and 2001 (Platt et al., 2005) and 2001 and 2011 (Simpson et al., 2014). Thus for ties, the later ethnicity is taken because it may better fit new categories offered at censuses. The reference category is White England and Wales-born. Immigrants from ethnic minority groups White, Indian, Pakistani, Bangladeshi, Chinese, Other Asian, Black Caribbean, Black African, Black Other, Mixed: Black/White, Mixed: Asian/White and Other are studied. For descendants, similar groups are observed but Pakistani and Bangladeshi, and Chinese and Other Asian are combined due to low risk-time and death event numbers[23]. White immigrants from Scotland, Republic of Ireland and Northern Ireland are included as a separate group. It is not possible to study mortality among the descendants of White immigrants (from other UK and Ireland or Europe) because 1991 did not offer any sub-categories for the ethnic group White. In 1991, a combination of written descriptions, together with multiple ticking of boxes on census forms led to the derivation of the mixed ethnic groups: Black/White and Asian/White (CeLSIUS, 2013).

5.3.1. Study sample

Figure 5.1 shows a Lexis diagram of the study design. At the beginning of observation (the 1991 census), LS members are observed (or at risk) as long as they are aged between 20 and 65. Individuals can enter through enumeration at census or immigration during the intercensal period. The lower 20-year age limit remains stationary, but the upper age limit increases by one year, each year, up to 86-years in 2012. For example, an LS member enumerated for the first time at the 1991 census is observed as long as they are aged between 20 and 65. An LS member who moves to England and Wales in 1994 is observed if they are aged between 20 and 68. An LS member enumerated for the first time at the 2001 census is observed if aged between 20 and 75. The study period spans 21-years from April 1991 to December 2012. Figure 5.2 shows age structures of White England and Wales-born, Whites born in Other UK and Ireland, immigrants and their descendants at the 1991 and 2011 censuses. Relative to White England and Wales-born and immigrants, descendants are very young, with few older than 30-34 years

[23] *These ethnic groups for descendants were initially estimated separately. The hazard ratios for Pakistanis and Bangladeshis, and Chinese and other Asians were similar and combined. Estimates for lowest level ethnic groups are available in Appendix E (Table 5)*

old in 1991 which increases to 50-54 years old in 2011 as the descendant population grows and ages. Given these differences in age structure between groups, several age designs were run[24]; age interactions were also tested[25]. The hazard ratios were robust to different upper age limit designs.

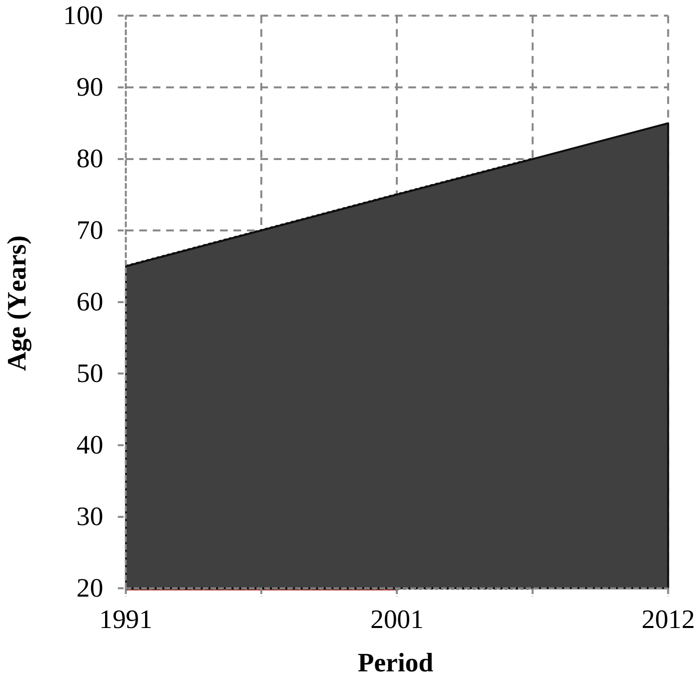

Figure 5.1. Lexis diagram of study design

Source: author's calculations based on ONS LS

Individuals were dropped if they were untraced (18,354; [4%]). It is not possible to match untraced individual's census data with their life event data and they cannot be studied over time. LS members can be untraced because they have not registered with the NHS (they may be young and healthy and do not feel the need to register or have only recently arrived in England and Wales); they may also have private healthcare. Consequently, this may indicate that traced people are those who register with the NHS because they are unhealthier and require care, cannot afford private healthcare or in the case of immigrants, are those who have lived in the country for longer. Tracing failures can also occur if the date of birth is incorrect on NHS records or the census forms. People were dropped if it was not possible to determine country of birth and/or ethnicity (1,200 [<1%]). Individuals (885 [<1%]) were also dropped if they had unchronological exit and re-entry dates. People can record temporary exits and returns from

[24] *Given the younger age structure of descendants, several models were fitted with different upper and lower age limits to test the effect this had on hazard ratios for descendants. These models are available in Appendix E (Table 10)*

[25] *Results from the age interaction models are available in Appendix E (Tables 7, 8 and Figure 1)*

England and Wales; for some these dates conflicted e.g. an exit date which was later than a re-entry date and it was not possible to accurately determine their risk-time contributions. A final sample of 555,111 people with 47,907 deaths is used to study mortality among immigrants and descendants.

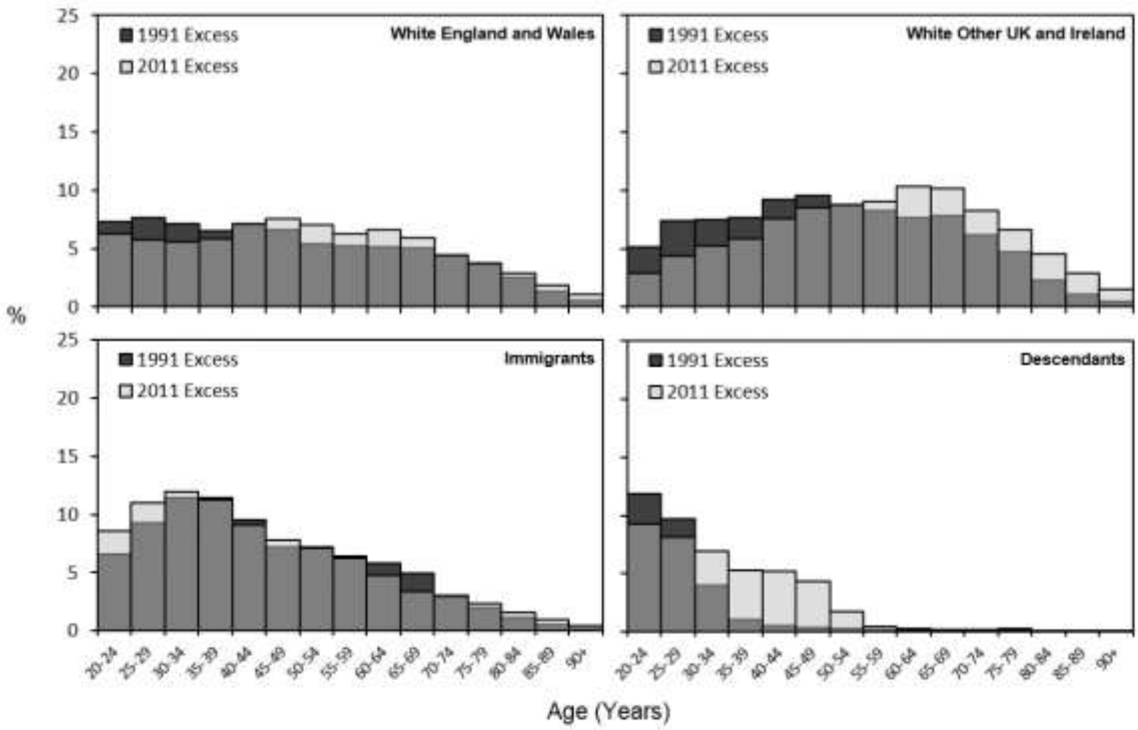

Figure 5.2. Age structure of England and Wales-born, immigrants and descendants

Source: author's calculations based on ONS LS

5.3.2. Statistical methods

Survival analysis is used to study all-cause mortality among immigrants and their descendants in England and Wales. The basic model is:

$$\mu_i(t) = \mu_0(t) \times \exp\left\{\sum_j \beta_j x_{ij}(t)\right\}$$

where $\boldsymbol{\mu_i(t)}$ denotes the hazard (or the 'force') of mortality for individual $\boldsymbol{i}$ at age $\boldsymbol{t}$ and $\boldsymbol{\mu_0(t)}$ denotes the baseline hazard i.e. mortality risk by age which is assumed to follow a Gompertz distribution (where the hazard of mortality increases exponentially as age increases) (Cleves et al., 2010); individuals are under the risk at entry (enumeration at census or immigration during the intercensal period) and are followed until the event of death, emigration or right-censoring in December 2012, whichever comes first. $\boldsymbol{x_{ij}(t)}$ represents the values of a variable measuring individual socio-demographic background; $\boldsymbol{\beta_j}$ is the parameter estimate for $\boldsymbol{x_{ij}(t)}$. Table 3.1

shows person-years at risk and number of deaths by covariates. However, it should be noted that person-months are used for analysis in order to minimise the number of ties in event and censoring times. Given that the ONS does not permit access to the day and month of birth of LS members (to ensure the continued anonymity of the individuals who are included in the LS sample), the assumption is made for date of birth that people are born in the middle of the year [July]).

Analysis controls for individual-level covariates age, sex, period and marital status. Control for age, by single month (the change in baseline hazard is calculated in months), is implicit and hazard ratios for age are not produced. Additionally, the analysis uses socioeconomic indicators occupation type, education level and housing tenure. All covariates are time-varying to allow for e.g. increased educational attainment over time or any changes in area of residence. The change in the covariates (if any) occurs at the point of census. The categorisation of covariates, alongside their risk-time and death event distribution can be found in Table 3.1. The higher proportion of missing data in occupation type is a result of failure to answer relevant questions at census. Additionally, individuals may be looking after their family and home, not had a job in the last ten years or have retired. The analysis was conducted with and without the missing data in each of the covariates and the hazard ratios remained similar across all of the analysis models.

Table 5.1. Person-years at risk and number of events by covariates.

	Years at risk	%	Deaths	%		Years at risk	%	Deaths	%
Age (years)					**Marital Status**				
20 to 24	773,340	9.2	380	0.8	Single	2,585,858	30.8	6,671	13.9
25 to 29	840,756	10.0	427	0.9	Married	4,692,818	55.9	28,770	60.1
30 to 34	890,928	10.6	591	1.2	Widowed	811,380	9.7	5,868	12.2
35 to 39	899,649	10.7	839	1.8	Divorced	274,170	3.3	6,458	13.5
40 to 44	879,503	10.5	1,293	2.7	Missing	24,876	0.3	140	0.3
45 to 49	847,880	10.1	1,908	4.0	**Period**				
50 to 54	779,788	9.3	2,847	5.9	1991-2001	3,613,479	43.1	14,529	30.3
55 to 59	715,538	8.5	4,348	9.1	2001-2012	4,775,622	56.9	33,378	69.7
60 to 64	654,757	7.8	6,568	13.7	**Ethnicity by country of birth**				
65 to 69	518,977	6.2	8,408	17.6	White UK-born	6,872,247	81.9	41,187	86.0
70 to 74	335,150	4.0	8,299	17.3	White Other UK and Ireland	273,057	3.3	2,578	5.4
75 to 79	182,361	2.2	7,307	15.3	*White Scottish*	140,833	1.7	1,151	2.4
80 to 84	66,073	0.8	4,281	8.9	*White Northern Irish*	41,091	0.5	353	0.7
85 +	4,402	0.1	411	0.9	*White Irish*	91,133	1.1	1,074	2.2
Sex					Immigrants	1,039,699	12.4	3,890	8.1
Male	4,114,042	49.0	27,726	57.9	*White*	373,436	4.5	1,536	3.2
Female	4,275,060	51.0	20,181	42.1	*Indian*	194,309	2.3	866	1.8
Occupation Type					*Pakistani*	117,423	1.4	405	0.8
Professional/Managerial	2,392,275	28.5	9,596	20.0	*Bangladeshi*	57,685	0.7	148	0.3
Skilled	3,121,385	37.2	16,620	34.7	*Chinese*	37,532	0.4	99	0.2
Unskilled	1,587,876	18.9	10,661	22.3	*Other Asian*	63,635	0.8	91	0.2
Missing	1,287,565	15.3	11,030	23.0	*Black Caribbean*	87,199	1.0	403	0.8
Education Level					*Black African*	36,514	0.4	152	0.3
Degree level +	1,321,569	15.8	4,085	8.5	*Black Other*	7,835	0.1	35	0.1
> A-level	630,858	7.5	1,712	3.6	*Mixed: Black/White*	6,377	0.1	25	0.1
< A-level	6,411,799	76.4	41,970	87.6	*Mixed: Asian/White*	7,196	0.1	27	0.1
Missing	24,876	0.3	140	0.3	*Other*	50,558	0.6	103	0.2
Housing Tenure					Descendants	204,098	2.4	251	0.5
Owned	6,140,135	73.2	31,007	64.7	*Indian*	47,213	0.6	29	0.1
Social Rented	1,344,906	16.0	12,279	25.6	*Pakistani & Bangladeshi*	33,962	0.4	33	0.1
Private Rented	801,811	9.6	3,036	6.3	*Chinese and Other Asian*	10,760	0.1	<10	0.0
Missing	102,249	1.2	1,585	3.3	*Black Caribbean*	26,928	0.3	60	0.1
Area of Residence Tyoe					*Black African*	26,880	0.3	22	0.0
London	1,192,492	14.2	5,668	11.8	*Black Other*	8,960	0.1	19	0.0
Metropolitan	1,764,451	21.0	11,372	23.7	*Mixed: Black/White*	22,901	0.3	36	0.1
Non-metropolitan	5,407,282	64.5	30,727	64.1	*Mixed: Asian/White*	12,005	0.1	11	0.0
Missing	24,876	0.3	140	0.3	*Other*	14,490	0.2	41	0.1
					Total	**8,389,101**	**100**	**47,907**	**100**

Source: author's calculations based on ONS LS

Table 5.2. Hazard ratios: all-cause mortality among White England and Wales-born, immigrants and their descendants.

Model 1	**[a]**			**Male**			**Female**			**[b]**			**Male**			**Female**		
	Haz Ratio	Sig	95% CI	Haz Ratio	Sig	95% CI	Haz Ratio	Sig	95% CI	Haz Ratio	Sig	95% CI	Haz Ratio	Sig	95% CI	Haz Ratio	Sig	95% CI
Sex																		
Male	**1**			*(Models are sex stratified)*						**1**			*(Models are sex stratified)*					
Female	0.66	***	0.64 - 0.67							0.59	***	0.58 - 0.60						
Period																		
1991-2001	**1**			**1**			**1**			**1**			**1**			**1**		
2001-2012	0.87	***	0.85 - 0.89	0.85	***	0.83 - 0.87	0.90		0.87 - 0.93	0.93	***	0.91 - 0.95	0.88	***	0.86 - 0.90	1.01		0.98 - 1.05
Ethnicity/country of birth																		
White England and Wales	**1**			**1**						**1**			**1**			**1**		
White Other UK/Ireland	1.23	***	1.19 - 1.28	1.22	***	1.15 - 1.28	1.26	***	1.18 - 1.34	1.15	***	1.10 - 1.19	1.11	***	1.06 - 1.17	1.19	***	1.12 - 1.27
Immigrants	0.80	***	0.77 - 0.83	0.80	***	0.77 - 0.84	0.79	***	0.75 - 0.84	0.73	***	0.71 - 0.76	0.75	***	0.72 - 0.78	0.71	***	0.68 - 0.75
Descendants	1.37	***	1.21 - 1.56	1.35	***	1.14 - 1.59	1.41	***	1.17 - 1.71	1.00		0.88 - 1.13	0.98		0.83 - 1.15	1.03		0.85 - 1.25
Occupation Type																		
Professional/Managerial										**1**			**1**			**1**		
Skilled										1.11	***	1.08 - 1.14	1.15	***	1.11 - 1.19	1.03		0.98 - 1.08
Unskilled										1.28	***	1.24 - 1.32	1.27	***	1.23 - 1.32	1.25	***	1.19 - 1.31
Missing										1.81	***	1.76 - 1.87	1.91	***	1.83 - 1.99	1.71	***	1.63 - 1.80
Education Level																		
Degree level +										0.73	***	0.70 - 0.76	0.72	***	0.69 - 0.75	0.74	***	0.70 - 0.78
> A-level										0.84	***	0.80 - 0.88	0.85	***	0.80 - 0.91	0.83	***	0.76 - 0.90
< A-level										**1**			**1**			**1**		
Missing										0.93		0.78 - 1.10	1.07		0.86 - 1.33	0.75	*	0.56 - 1.00
Housing Tenure																		
Owned	*(Model 1a is not adjusted for socieconomic characteristics)*									**1**			**1**			**1**		
Private Renting										1.58	***	1.55 - 1.62	1.59	***	1.54 - 1.64	1.56	***	1.51 - 1.62
Social Renting										1.25	***	1.21 - 1.30	1.25	***	1.19 - 1.32	1.24	***	1.17 - 1.32
Missing										3.03	***	2.87 - 3.21	2.64	***	2.45 - 2.85	3.56	***	3.28 - 3.87
Area of Residence Type																		
Non-metropolitan										**1**			**1**			**1**		
London										1.01		0.98 - 1.04	1.04	*	1.00 - 1.08	0.99		0.94 - 1.03
Metropolitan										1.11	***	1.09 - 1.14	1.10	***	1.07 - 1.13	1.13	***	1.09 - 1.17
Marital Status																		
Married										**1**			**1**			**1**		
Single										1.48	***	1.44 - 1.52	1.53	***	1.48 - 1.59	1.38	***	1.31 - 1.45
Divorced										1.26	***	1.22 - 1.30	1.29	***	1.25 - 1.35	1.21	***	1.15 - 1.26
Widowed										1.16	***	1.12 - 1.19	1.23	***	1.17 - 1.29	1.10	***	1.06 - 1.14

Notes: Significance levels at 1% (***), 5% (**) and 10% (*); missing categories in area of residence and marital status omitted from models

Source: author's calculations based on ONS LS

5.4. Results

Model 1a (Table 5.2)[26] analyses mortality patterns among the White England and Wales-born, White Other UK and Ireland, and immigrants and their descendants to determine whether any mortality differences exist between these broader groups. Model 1a controls for age, sex and period. The models shows that relative to White England and Wales-born, immigrants have low mortality and their descendants have high mortality. There are no differences between men and women when the model is sex-stratified. Model 1b (Table 5.2) adjusts for socioeconomic characteristics, marital status and the area of residence type. Mortality among immigrants remains low and is emphasised. Mortality among descendants attenuates to the mortality level of White England and Wales-born (but is still high relative to immigrants and the confidence intervals do not overlap). Occupation type and education level are the key covariates in this mortality attenuation. Model 1b additionally observes no mortality differences between men and women. However, while in the sex-adjusted models mortality among women is lower than men, hazard ratios are slightly higher for women in the sex-stratified models. Mortality declines by period and increases with age (not shown). Mortality increases with a lower education level and occupation type. Those who own their homes have lower mortality than those who rent (either privately or socially rented). Married people have lower mortality than single, divorced or widowed and those living in other urban areas have higher mortality than those in rural areas or in London. In both of the models the White Other UK/Ireland group have persistent high mortality.

Model 2a (Table 5.3) classifies immigrants and their descendants by ethnic group to observe whether the general pattern found in Model 1 (low mortality among immigrants and high, socioeconomic driven mortality among descendants) varies by ethnic groups. All immigrants (except Black Other and the mixed groups) have low mortality relative to the White England and Wales-born. The descendants of Pakistani/Bangladeshi, Black Caribbean, Black Other and Other immigrants have high mortality relative to the White England and Wales-born and their respective immigrant groups. In model 2b, after adjusting for socioeconomic characteristics, marital status and the area of residence type (hazard ratios for additional covariates are not shown in Table 5.3; but are similar to those in Model 1b (Table 5.2)), high mortality among descendants of Pakistani/Bangladeshi and Black Other attenuates towards the White England

[26] *Models display hazard ratios, significance levels and 95% confidence intervals. All models from Chapter II are reproduced in Appendix E (Tables 1-4) and additionally display the log hazard, standard errors, z-scores and values for constant.*

and Wales-born baseline but remains high (hazard ratios are no longer statistically significant). High mortality among the descendants of Black Caribbeans persists and remains high relative to White England and Wales-born. The descendants of Black Africans and Chinese/Other Asian now have low mortality (though for the latter confidence intervals are very wide and event numbers are less than 10). In both models, White immigrants from Scotland and Northern Ireland have persistent high mortality. Initial high mortality among White immigrants from the Republic of Ireland attenuates after accounting for their socioeconomic characteristics. Low mortality is emphasised for immigrants and Mixed: Black/White immigrants now have low mortality.

Table 5.3. Hazard ratios: all-cause mortality among England and Wales-born, immigrants and their descendants by ethnic group.

Model 2	**[a]**			**[b]**		
	Haz Ratio	Sig	95% CI	Haz Ratio	Sig	95% CI
Sex						
Male	**1**			**1**		
Female	0.66	***	0.64 - 0.67	0.59	***	0.58 - 0.60
Period						
1991-2001	**1**			**1**		
2001-2012	0.87	***	0.85 - 0.89	0.93	***	0.91 - 0.95
Ethnicity by Country of Birth						
White England and Wales	**1**			**1**		
White Scottish	1.23	***	1.16 - 1.31	1.25	***	1.18 - 1.33
White Northern Irish	1.23	***	1.11 - 1.36	1.14	*	1.02 - 1.26
White Irish	1.23	***	1.16 - 1.31	1.05		0.99 - 1.12
Immigrants						
White	0.81	***	0.77 - 0.86	0.81	***	0.77 - 0.85
Indian	0.83	***	0.77 - 0.89	0.83	***	0.77 - 0.88
Pakistani	0.81	***	0.73 - 0.89	0.70	***	0.63 - 0.77
Bangladeshi	0.83	**	0.70 - 0.97	0.58	***	0.49 - 0.68
Chinese	0.66	***	0.54 - 0.80	0.60	***	0.49 - 0.73
Other Asian	0.44	***	0.36 - 0.54	0.40	***	0.33 - 0.50
Black Caribbean	0.90	**	0.81 - 0.99	0.70	***	0.63 - 0.77
Black African	0.74	***	0.63 - 0.86	0.56	***	0.48 - 0.66
Black Other	1.27		0.91 - 1.77	0.91		0.65 - 1.27
Mixed: Black/White	0.97		0.65 - 1.43	0.69	*	0.46 - 1.02
Mixed: Asian/White	0.84		0.57 - 1.22	0.86		0.59 - 1.26
Other	0.65	***	0.53 - 0.79	0.54	***	0.44 - 0.65
Descendants						
Indian	1.03		0.72 - 1.49	0.88		0.61 - 1.26
Pakistani & Bangladeshi	1.79	***	1.27 - 2.51	1.32		0.94 - 1.86
Chinese & Other Asian	0.13	**	0.02 - 0.93	0.10	**	0.01 - 0.68
Black Caribbean	2.30	***	1.78 - 2.96	1.70	***	1.32 - 2.19
Black African	0.84		0.56 - 1.28	0.58	***	0.38 - 0.88
Black Other	2.16	***	1.38 - 3.39	1.37		0.87 - 2.15
Mixed: Black/White	1.14		0.82 - 1.58	0.75	*	0.54 - 1.04
Mixed: Asian/White	0.75		0.42 - 1.36	0.66		0.37 - 1.20
Other	1.84	***	1.36 - 2.50	1.23		0.91 - 1.67

Notes: Significance levels at 1% (***) 5% (**) and 10% (*); model 2b further adjust for occupation type, education level, housing tenure, area of residence type and marital status. The coefficients are very similar to those in Model 1b and are not displayed.

Source: author's calculations based on ONS LS

5.5. Discussion

In summary and with reference to hypotheses, the study has shown that mortality among the descendants of immigrants (combined) reversed from low mortality among immigrants (who have a *migrant mortality advantage*) and was higher than the mortality of the White England and Wales-born (*1*). After adjusting for socioeconomic characteristics, high mortality among descendants attenuated to the mortality level among the White England and Wales-born but remained high relative to immigrants (*2*). The ethnic group analysis indicated some important subgroup differences among descendants in, for example, the persistent high mortality among the descendants of Black Caribbean migrants after adjusting for differences in socioeconomic characteristics and low mortality among the descendants of Black Africans (*3*). However, the descendants of immigrants in England and Wales are still young and the number of deaths events remains small; caution should therefore be exercised when interpreting their hazard ratios. As with Scott and Timaeus's (2013) previous attempt to analyse mortality among the descendants of immigrants by ethnic group, findings lack statistical precision and may not be robust.

Nonetheless, the initial finding of high mortality among descendants is an important one and merits discussion. As to why we might observe this attenuation, it is important to recognise the role of health behaviours, particularly smoking. Descendants of acculturated immigrants may never learn the culture-specific behaviours and beliefs associated with the country of origin (and are believed to combine to produce lower mortality among immigrants) and practice behaviours typically associated with the White England and Wales-born population. Typical behaviours in western host societies include higher smoking rates, higher alcohol intake and an unhealthier diet (Beiser, 2005). Smoking rates are higher among descendants, particularly among Black Caribbeans (Smith et al., 2009; Aspinall and Mitton, 2014); the exceptions are descendants from Other White and Bangladeshi and Chinese groups (male only) (Aspinall and Mitton, 2014). Smoking is the biggest cause of preventable death in the UK (Millward and Karlsen, 2011) and its role in mortality among descendants, specifically Black Caribbeans, may be important. Smoking rates among Black Caribbean men have increased inter-generationally across age groups 18-29 (*18 to 28%*), 30-44 (*22 to 31%*) and 45+ (*21 to 30%*). Among Black Caribbean women, sizeable increases are seen across the same age groups (18-29; *10 to 23%*, 30-44; *7 to 25%* and 45+; *7 to 22%*). Black Caribbeans, especially women (relative to other female ethnic minority descendant groups), have the highest smoking prevalence of all ethnic minority descendants (Aspinall and Mitton, 2014). Some studies also note inter-generational deteriorations in diet (Harding et al., 2008) and increased alcohol intake (Smith et al., 2009). The increased prevalence of unhealthy behaviours among descendants increases their risk of developing behaviour-related chronic diseases which will resultantly lead to higher all-cause mortality.

Additionally, descendants (unlike immigrants) may not benefit from possible selection effects in migration. Immigrants are thought to select for good health through immigration, creating a unique and healthy sample of people from the country of origin (Franzini et al., 2001). The hazard ratios among immigrants show little variation by ethnic group or sex, tend to indicate a migrant mortality advantage, and the size of this advantage relative to the White England and Wales-born is similar across ethnic minority groups with markedly different socioeconomic backgrounds. This may provide some evidence for selection effects among immigrants and possibly explain why descendants do not have low mortality. Through migration, immigrants may also select for traits such as drive and resilience; descendants may not have these traits. Further, given that descendants are born in England and Wales, they have a different frame of reference in the White England and Wales-born (Heath and Li, 2008). While immigrants may feel that they are doing as well as other ethnic minorities and better than peers in the country of origin (their frame of reference), descendants may feel they fare worse than White England and Wales-born and may thus not benefit from a migrant hope effect. (Anson, 2004). Such perceptions may produce negative emotions that translate into poor health via psycho-neuro-endocrine mechanisms and stress-induced behaviours e.g. smoking prevalence (Lynch et al., 2000).

Upon adjusting for their socioeconomic characteristics, high mortality among descendants attenuated to the mortality among the White England and Wales-born. Rather than an inter-generational worsening in socioeconomic circumstances (simple risk-time distributions for the socioeconomic variables showed that the descendants tended to have more favourable risk distributions relative to immigrants), results could be indicative of the increased exposure of descendants over the lifecourse to poor socioeconomic circumstances. The socioeconomic status of immigrants determines the socioeconomic status of descendants during childhood (Spallek et al., 2011) and immigrants often experience poverty shortly after migrating to Britain (Bhopal, 2002). Descendants may experience their childhood in these poor socioeconomic conditions. This longer and earlier exposure (relative to immigrants) may result in greater risk accumulation over the lifecourse for diseases associated with poverty in e.g. an increased risk for some heart and respiratory diseases (Galobardes et al., 2004) and thus higher all-cause mortality. While immigrants also experience poor socioeconomic circumstances, they arrive in the UK as adults, and these poor conditions have less time to influence their health and mortality. Further, non-western immigrants may also benefit from a rapid health transition, which could precede the gradual, cumulative effect of low socioeconomic status (Spallek et al., 2011).

The study does have limitations. First, the number of deaths among the descendants is small. Consequently, confidence intervals are very wide and some hazard ratios may not be robust (though still indicate important ethnic sub-group differences which are not present among immigrants)[27]. Second, using country of birth by ethnicity to define groups meant it was not possible to differentiate descendants by generation. The descendant group could be a mix of second, third and fourth generation at very different stages of acculturation. Third, using self-reported ethnicity may constitute a self-selection effect where acculturated people identify as White and less-acculturated individuals identify as an ethnic minority. The latter group may maintain stronger cultural ties to their (or their relatives) country of origin and practice cultural beliefs and health behaviours which operate to produce lower mortality. Fourth, it is possible that the immigrant groups are not the (grand)parent cohort for the descendant groups in the study. An immigrant population is a changeable population as individuals come and go over time.

Lastly, it is important to acknowledge the socioeconomic variables as possible confounders associated with both ethnicity and mortality. Research by Fischbacher et al. (2014) found that socioeconomic measures can be inconsistently associated with deaths from cardiovascular disease (education level showed the most consistent associations across ethnic group and is adjusted for here). This study has, at various stages, adjusted for combinations of education level, occupation type, housing tenure and Carstairs Index[28]. There were some changes in hazard ratios but key findings remain consistent (among descendants small changes in hazard ratios led to some findings wavering in and out of statistical significance but this is likely due to a lack of statistical power through small populations and death numbers). For initial analysis, interactions were conducted between education level/occupation type and ethnic group[29] (the two key socioeconomic covariates in the attenuation of high mortality among descendants; the

[27] *Appendix E (Table 11) shows results from multilevel logistic regression model using limiting long-term illness as a proxy for mortality. Levels of LLTI tend to be higher among descendants relative to immigrants, reflecting results from the survival models*
[28] *Results from the model which adjusts for Carstairs Deprivation Index are available in Appendix E (Table 6)*
[29] *Results from education level and occupation type interaction models are available in Appendix E (Table 9)*

scale of the patterns differed across the ethnic groups but the direction of the gradient remained similar). However, it is acknowledged that it is not possible to rule out residual confounding in the analysis.

The initial findings from this study corroborate previous international studies which observe higher mortality among descendants which attenuates to the mortality of the host population, after adjusting for socioeconomic characteristics (Buckley, 2011; Tarnutzer and Bopp, 2012; De Grande et al., 2014). In the previous UK study by Scott and Timaeus (2013), the authors showed low immigrant mortality and high mortality among descendants of Black Caribbeans (which attenuated on adjustment for socioeconomic characteristics). This study also observed low immigrant mortality (a migrant mortality advantage) and high mortality among Black Caribbean descendants (although mortality remained high after adjustment for socioeconomic status). However, many descendants have still not reached ages of high mortality and caution should continue to be exercised when interpreting hazard ratios for descendants. As Scott and Timaeus (2013) argue, as the UK-born ethnic population grows, ethnic differentials may well change. This study benefitted from a slightly older sample with more deaths to analyse among descendants (252 to 129 in the study by Scott and Timaeus). Despite this, the age structure and number of deaths is still too small to produce reliable estimates for descendants by ethnic group.

The study has shown that descendants of immigrants (combined) had higher mortality than immigrants and White England and Wales-born. Among descendants, the low mortality which is characteristic of immigrants reversed to high mortality and they do not benefit from a migrant mortality advantage. This high mortality then attenuated to the mortality level among the White England and Wales-born after accounting for their socioeconomic characteristics but remained high relative to immigrants. The additional ethnic sub-group analysis suggested important sub-group differences among the descendants, namely in the persistent high mortality of Black Caribbeans. However, mortality estimates among the other ethnic minority descendant groups still lack statistical precision and caution should be exercised when interpreting them. When the age structure of descendants is old enough to permit a more robust analysis, we should seek to confirm (or challenge) these important sub-group differences. Further, given this ageing of descendants, researchers should also endeavour to analyse cause-specific mortality to provide insight into the persistent high mortality among descendants of Black Caribbean immigrants to observe whether this group suffers higher death rates from, for example, smoking-related diseases.

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Conclusions

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6.1. Introduction

This thesis has investigated the *migrant mortality advantage*, a phenomenon which posits that migrants have low mortality relative to non-migrants living in western countries (Anson, 2004). Among their descendants the advantage can persist, wear off or even reverse (Tarnutzer and Bopp, 2012). While the migrant mortality advantage has been studied before, the actuality of the advantage is contested and its causes poorly understood. Primary mechanisms include the *healthy migrant effect* (selection by good health), *cultural factors* (health-protective, culture-specific behaviours which work to produce low mortality) and among non-western immigrants, a *rapid health transition* (where immigrants benefit immediately from access to healthcare for infectious diseases which precedes the gradual influence that chronic diseases exert over their mortality). However, two confounding factors exist in *registration uncertainty* (uncertainty in the dates and reporting of moves) and *health-motivated remigration* (return migration by poor health) which can depress migrant mortality rates, creating a data artefact. Most research fails to account for, or even investigate, the two possible confounding causes. This, in turn, generates uncertainty surrounding the size and even validity of the migrant mortality advantage among migrants in western countries and questions the degree of influence of the other main causal factors.

To address this uncertainty, this thesis adopted a holistic approach to the study of immigrant mortality by explicitly modelling the impact of registration uncertainty on mortality rates and through investigating health-motivated remigration among immigrants. If the two confounding factors could be ruled out as explanations for low immigrant mortality, the migrant mortality advantage could be shown to be real and not a data artefact. Moreover, some combination of the healthy migrant effect, cultural factors and immigrant health transition could be confirmed as the primary causes of the migrant mortality advantage. Understanding of these factors would also be improved through detailed analysis of mortality by sex, generation, over age and from specific causes. There are few large-scale studies on migrant mortality, particularly in Europe, and the thesis would provide a significant contribution to the literature in this growing field of research.

Further, it is generally agreed that explicit health policies are required in all countries which have a sizeable proportion of immigrants in their population (Rechel et al., 2013). Given that immigrants account for 14% (Smith, 2013), and ethnic minorities 20% (Jivraj, 2012), of the UK population, it is quite surprising that no large-scale study of immigrant mortality has been conducted before. Explicit health policies cannot be developed if policymakers do not possess adequate information on the patterns and causes of mortality among migrants in England and Wales.

The thesis had two aims:

1 *To examine mortality patterns among immigrants and their descendants in England and Wales.*

2 *To investigate causes of mortality differences between immigrants, their descendants and England and Wales-born population.*

To achieve these aims, Chapter I investigated immigrant mortality as a possible data artefact created as a consequence of uncertainty in the registration of migration events. Sensitivity models were fitted to explicitly measure the impact of registration uncertainty on immigrant mortality rates. If registration uncertainty could be ruled out as a confounding cause, this would greatly reduce uncertainty surrounding the actuality of the migrant mortality advantage (with one of two main possible confounders accounted for). After fitting sensitivity models, chapter I then further adjusted for socioeconomic characteristics to observe if any remaining mortality differences could be explained by socioeconomic differences between immigrants and England and Wales-born. The same model was also stratified by sex to observe if mortality patterns by country of birth were consistent by sex or driven by men or women. Given that there are good reasons to expect differences in mortality between male and female immigrants, consistency in mortality patterns between men and women would provide some evidence for selection effects. Finally, Chapter I used age as a proxy for length of residence to observe if low mortality among immigrants relative to England and Wales-born persisted or attenuated over duration of stay. This would provide some insight into the acculturation process, which posits that the migrant mortality advantage will wear off over time due to the adoption of host society behaviours and beliefs.

Chapter II investigated for the presence of health-motivated remigration among immigrants in England and Wales to determine whether remigrations related to poor health status could play a role in depressing migrant mortality rates in England and Wales. Chapter II investigated the second of two possible confounding causes of the migrant mortality advantage. If no evidence was found for health-motivated remigration this, combined with findings from chapter I, would demonstrate the migrant mortality advantage to be real and not a data artefact. Additionally, uncertainty surrounding the other main causes associated with the migrant mortality advantage (selection, cultural factors and health transition) would be removed. Chapter II first modelled remigrations to observe which immigrant populations were most likely to leave England and Wales. Then the remigrations were modelled contingent on long-term illness to see if there was evidence of health-related remigration. A model was fitted at young (20-64) and old ages (65+) to observe if health-motivated remigrations represented a salmon bias or unhealthy remigration effect.

Chapter III helped achieve these two aims by investigating specific causes of death to discover which diseases drove the low all-cause mortality observed in Chapter I and indeed whether low all-cause mortality could coexist with high mortality from specific causes of death. Chapter III simultaneously modelled mortality from cardiovascular (CVD) diseases, cancers, respiratory diseases, infectious diseases and other causes of death among men and women, modelling their mortality before and after adjusting for socioeconomic characteristics. Modelling causes of death would provide insight into causes of low immigrant mortality because health behaviours link to specific diseases, particularly chronic diseases. Chapter III then used age as a proxy for length of residence to see if mortality differences in the two main chronic disease groups in the study (CVD and cancers) persisted or attenuated to the mortality level among the England and Wales-born over time. Chapter III would provide valuable insight into the health transition by investigating whether mortality from CVD and cancers became more influential for migrants over time.

Chapter IV helped achieve these aims by investigating mortality among the descendants of immigrants. This final chapter sought to observe whether the low mortality observed among immigrants found in chapter I persisted (*mortality remained low*), attenuated (*mortality became similar to England and Wales-born*) or reversed (*mortality became higher than immigrants and England and Wales-born*) among descendants of immigrants living in England and Wales. The fourth chapter initially modelled immigrants, their descendants and the White England and Wales-born population as broader groups (fitting both sex-adjusted and sex-stratified models both before and after adjusting for socioeconomic characteristics) to observe the main mortality patterns. Chapter IV then classed the groups by ethnic background to observe whether the main patterns identified in the first model persisted or varied based on the ethnic background of descendants. Chapter IV would provide insight into selection effects because one of the main differences between immigrants and their descendants is that descendants do not migrate, they are born in the host country. If low mortality was not characteristic of descendants, this could indicate that selection effects in migration operate to produce low migrant mortality. Similarly, the chapter would provide valuable insight into the role of possible protective cultural factors. Acculturation is regarded as crucial to the inter-generational changes in health behaviours. If the descendants did not benefit from a migrant mortality advantage, findings could also indicate that cultural factors play an important role in preserving low mortality among migrants in the UK.

6.2. Summary of findings

In chapter I, immigrant mortality rates were shown to be robust to uncertainty in the registration of migration events. Regardless of whether immigrants began contributing risk-time from the date specified with a doctor upon registration with the NHS or from enumeration at census, or whether immigrants who became ‘lost to follow-up’ contributed risk-time up until 2-, 4- or 7-years after their final census, there was little observable change in mortality. Prior to adjusting for individual-level socioeconomic characteristics, immigrants from Pakistan, Western Europe and Other Asia had low mortality relative to people born in England and Wales. Immigrants from Scotland, the Republic of Ireland and Northern Ireland had high relative mortality. After adjusting for individual socioeconomic characteristics, low mortality became apparent among immigrants from India, Bangladesh, Other Caribbean, East and South Africa, China and the Rest of the World. Immigrants from Jamaica, West and Central Africa and Eastern Europe had similar mortality to non-migrants born in England and Wales. Mortality patterns were largely consistent by gender, though Jamaican men were found to have low mortality while women from Jamaica had higher mortality. Finally, using age as a proxy for length of residence, low mortality among immigrants was found to converge towards the England and Wales baseline over time but still persist (particularly among immigrants from South Asia and China) at older ages.

In chapter II, the analysis found little support for health-related remigration among migrants. For most migrant groups there was no relationship between health status and the likelihood of remigration (many groups had odds which indicated a lower likelihood but the results were not significant). However, among migrants from India, Pakistan and Bangladesh, there was some evidence of health-related remigration. South Asians were more likely to remigrate if they were in poor health. The two age group models showed that the health-related remigration among immigrants from India, Pakistan and Bangladesh was limited to pre-retirement ages (20-64). At older ages (65+), all three groups had a decreased probability of remigrating if they reported suffering a limiting long-term illness. Modelling mortality alongside remigration (as part of a three category dependant variable) showed that South Asians who *stayed* in England and Wales were more likely to die if they reported an LLTI. This suggested that Souths Asians who *left* England and Wales with an LLTI would also have a higher mortality risk. Further interacting duration of residence with country of birth and LLTI showed that the relationship between poor health and remigration among South Asians was limited to those who had lived in England and Wales for less than 10 years. Findings were more indicative of an unhealthy remigration effect (remigration based on poorer general health) at young ages and not a salmon bias effect at older ages.

In chapter III, low all-cause mortality among immigrants (previously observed in chapter I and re-affirmed over a longer time period in chapter III) was shown to be driven by low chronic disease mortality (particularly for cancers but in some cases, immigrants from Western Europe, East and South Africa and Other Asia, men from Jamaica and women from Bangladesh, by low CVD mortality). Low all-cause mortality was often found to coexist with lower mortality from respiratory diseases and higher infectious disease mortality among non-western (South Asian, Caribbean and African) immigrants. However, these two disease groups contributed little to the overall mortality among immigrants. Among men, CVD mortality was the leading cause of death (especially South Asians) while among women, cancer was the leading cause of death (except among South Asian women, for whom cardiovascular disease mortality was the leading cause of death). The high mortality among Jamaican women previously observed in chapter I was shown to be driven by high cardiovascular disease mortality (particularly before adjusting for socioeconomic status). Using age as a proxy for length of residence, differences in CVD mortality were observed to remain constant by age between immigrants relative to the England and Wales-born, but cancer patterns showed some signs of convergence to the cancer mortality level among England and Wales-born (though was still low among migrants by age 80).

In chapter IV, mortality among the descendants of immigrants was observed to be higher than both White England and Wales-born and immigrants. After adjusting for their socioeconomic status, mortality among descendants attenuated to the mortality level among the White England and Wales-born, suggesting their high mortality was driven by their low socioeconomic status. However, even after this adjustment, mortality among descendants remained high relative to immigrants. Patterns were consistent for both sexes. When the broad groups were classed into ethnic minorities, this pattern persisted among immigrants but among descendants there was variation across ethnic groups. Descendants of immigrants with Black Caribbean origins had persistent, high mortality before and after adjusting for socioeconomic status. Descendants of immigrants with Pakistani, Black Other and Other origins had initial high mortality, but it was no longer statistically significant after adjusting for socioeconomic status. The descendants of immigrants with Chinese/Other Asian and Black African origins initially had similar mortality to White England and Wales-born, which became low after adjusting for their socioeconomic status.

6.3. Conclusions

Based upon the findings from each chapter, it is possible to draw several conclusions from this research. First, many migrant populations living in England and Wales experience a migrant mortality advantage, though there is some variation in its size and scale. Second, the migrant mortality advantage is real and not a data artefact caused by registration uncertainty or health-related remigration. These two factors can therefore be ruled out as confounding causes of the migrant mortality advantage. Third, low mortality among migrants is driven by low mortality from chronic diseases (predominantly from cancers but in some groups from cardiovascular diseases). In some migrant groups a migrant mortality advantage coexisted with high mortality from specific causes of death such as infectious diseases. Finally, descendants of migrants do not experience a migrant mortality advantage. Even after adjusting for socioeconomic status, their mortality is only similar to the White England and Wales-born and is still high relative to migrants.

These findings, in turn, suggests that selection effects, cultural factors and the immigrant health transition are responsible for the migrant mortality advantage. But what evidence is found for these factors? The interaction model in chapter I provided some evidence for selection effects and acculturation. It showed the migrant mortality advantage was most pronounced at youngest ages and then diminished over age (or "time" as age is used as a proxy for length of residence). This is consistent with the idea that selection effects are strongest just after migration and wear off over time as migrants acculturate to the beliefs, attitudes and behaviours of the host society. Figure 1 in Appendix B showed that a large proportion (between 70 and 85%) of most migrants entered the country before age 35. This pattern, combined with the interactions, suggests that the size of the advantage decreases when the migrant stock is no longer replenished on a large-scale by newly selected and unacculturated migrants from the country of origin. We can assume that most of the migrants at ages 40 and above (where new arrivals comprise less than 10% of the age group; a figure which further decreases with age) have lived in England and Wales for longer and have had more time to acculturate to the beliefs, attitudes and behaviours of the host society.

The findings also reflect selection effects in that, chapters I, III and IV showed consistency in the size and scale of the mortality advantage between men and women. This provides evidence for selection effects given that traditionally we expect to see gendered mortality differences. The literature suggests that women are limited to a secondary, supportive role in the migration process and migrate primarily for family reunification (Sotelo and Cranford, 2006; Shauman and Noonan, 2007). If this was the case the migrant mortality advantage should be more marked among male migrants who take the decision to migrate and drive the migration, unlike women who move largely to reunite their families. However, this is not the case for England and Wales. Second, chapter IV observed that the descendants of immigrants do not experience a migrant mortality advantage. This could be because they do not move and do not benefit from selection effects.

Additionally in chapter IV, marked ethnic differences in mortality among migrants and their descendants were expected. Instead, the presence of a mortality advantage among migrants was observed across a diverse range of ethnic groups and the advantage relative to the England and Wales-born was of a similar size. This could indicate that the strength of the selection effects outweighs the role of contextual factors such as socioeconomic background in determining migrant mortality, particularly when their descendants had similar (if not better) socioeconomic profiles but did not experience a mortality advantage. This links well into the notion of a socioeconomic mortality paradox among migrants (Razum et al., 1999). The fact that adjusting for socioeconomic characteristics emphasised the size of the mortality advantage suggested that many of the migrant groups were already at a socioeconomic disadvantage relative to the England and Wales-born population. Finally, chapter II observed low odds of remigration in bad health for many of the migrant groups. Successfully moving countries may require a certain level of good health and being ill may be predictive of staying where you are (Norredam et al., 2014).

The findings may reflect protective cultural factors in that, in chapter III, many immigrants had low mortality from cancers and CVD; the main chronic disease groups. The sex-stratified cause of death models in appendix D (tables 22-29) also showed that most migrants had low mortality from lung cancer and alcohol-related mortality, although Indians had higher alcohol-related mortality which attenuated upon adjustment for socioeconomic status; confirming previous UK findings (Hurcombe, 2010). Lung cancer and alcohol-related mortality are directly influenced by specific health behaviours; lung cancer is almost entirely determined by smoking (Parkin and Khlat, 1995). In general, three behaviours have been intrinsically linked with increased chronic disease risk: smoking, diet and a sedentary lifestyle (WHO, 2006). Thus, low mortality among migrants from CVD, cancers and alcohol-related mortality suggests that the prevalence of chronic-disease related behaviours is lower among migrants relative to England and Wales-born.

However, not all chronic disease-related mortality was low. Diabetes mortality was high among Indians, Bangladeshis, Jamaicans and Other Caribbeans. This reflects previous findings from a large-scale European study on diabetes mellitus among migrants (Vandenheede et al., 2012). High diabetes mortality among migrants is linked to increased genetic susceptibility, enhanced by gene-environment interactions and marked socioeconomic change upon arrival in the host country (Spallek et al., 2011; Vandenheede et al., 2012). Finally, deaths from accidents and violence were low among all migrant groups. In general, first-generation immigrants are more risk-averse than natives (Algan et al., 2012) and an enduring commitment to the country of origin is thought to preserve this trait (Bonin et al., 2009). Incidentally, descendants of migrants tend to be as risk-loving as the host population and can be even more risk-taking (Algan et al., 2012).

Chapter IV found that descendants did not experience a migrant mortality advantage. The loss of a migrant mortality advantage intergenerationally could, along with the loss of any selection effects, relate to adverse changes in health behaviours. The acculturation process is crucial to intergenerational changes in health behaviour (Spallek et al., 2011). If immigrant relatives are fully acculturated into the host society, their descendants will not learn the protective, culture-specific behaviours associated with the country of origin. That descendants have high mortality relative to migrants, and similar mortality to England and Wales-born, could suggest that they practice behaviours which are similar to those of the host population, while immigrants (at least initially) practice healthier, culture-specific behaviours which help preserve lower mortality. Many studies in the UK find an intergenerational deterioration in health behaviours between immigrants and their descendants (Harding et al., 2008; Smith, 2009; Aspinall and Mitton, 2014).

Among non-western immigrants, there was partial evidence of an immigrant health transition. Chapter III showed that non-western immigrants had high mortality from infectious diseases relative to the England and Wales-born, but infectious diseases contributed little to their overall mortality. The immigrant health transition posits that mortality from infectious diseases falls due to healthcare access and is no longer the main cause of death among non-western migrants after they migrate (Spallek et al., 2011). Chapter III also observed some convergence of cancer mortality over time indicating that it was becoming more influential as a cause of death. However, there was no convergence in CVD mortality over time. If, as the immigrant health transition states, this is a result of exposure to new chronic disease risk factors and acculturation to the host society, CVD mortality should also have become more influential over time given that cancer and cardiovascular diseases share common risk factors. However, this was not the case.

6.4. Opportunities for further research

It was not possible to directly adjust for length of residence among migrants enumerated at the 1971 census because there was no information on the date of migration to England and Wales. Instead, age was used as a proxy for length of residence supplemented by information on age at migration. Length of residence will play an important role in explaining mortality differences between migrants and the host population. Future studies could adopt a shorter time period (i.e. exclude those present in the LS in 1971 for whom there is no date of entry) or use information from the question asked about year of arrival from the 2011 census ("if you were not born in the United Kingdom, when did you most recently arrive to live here?") to study length of residence. This would make an important contribution showing whether the advantage wears off with length of stay. Harding (2003) has previously shown that cardiovascular and cancer mortality among South Asian immigrants increased with duration of residence in England and Wales.

Future research could also investigate age at migration. Particularly in relation to the "healthy migrant effect", the strength of selection effects are likely to be quite different for people who move for work, later on in life for family reunification, or in childhood. A review of Canadian research into migrant health and mortality suggests that the healthy migrant effect is strongest during early adulthood but less so during childhood/adolescence and later life (Vang et al., 2015).

The finding of high mortality among descendants relative to migrants even after adjusting for differences in their socioeconomic status was an important one. However, while the ethnic sub-group analysis was interesting, hazard ratios among descendants were based on quite low risk-time contributions and a small number of deaths. As Scott and Timaeus (2013) argued when they conducted similar research using the LS between 1991 and 2006, ethnic minority group differentials in mortality are likely to change as the descendants population grows in size and ages. As life event information continues to be linked to the LS and especially when the 2021 census is linked to the LS, a similar analysis could be repeated to confirm or challenge these findings. If numbers permit, cause-specific mortality could also be conducted to see if the high mortality among descendants of Black Caribbeans is driven by high mortality from a particular cause.

In a similar vein, research into health behaviours among migrants and their descendants would provide valuable information on acculturation and the intergenerational acculturation process. Currently, while it is very likely that cultural factors contribute to low mortality, it is unclear whether migrants practice healthy behaviours because they come from countries where healthy behaviours are more often practiced, or because those with better health behaviours migrate (a behavioural selection effect). Moreover, while some of the findings indicate healthy behaviour, recent adverse changes in health behaviours may predate their effect on mortality. For example, Bangladeshi men in the UK have quite high smoking rates (Aspinall and Mitton, 2014), but in appendix D mortality from lung cancer is still low. As they age, cancer mortality may increase unless other factors, such as nutritional or genetic, afford some protection (Khlat and Courbage, 1996).

Finally, as Appendix F shows, frailty models were initially fitted. Frailty models are used to describe the influence of unobserved heterogeneity in survival models. The intention of the models was to examine selection effects. While the analysis would not have explicitly observed selection, it would have facilitated for detection, and adjustment for, unobserved characteristics which differentiate migrants from the England and Wales-born population. However, while the results were robust, some of the models would not converge. Frailty modelling require strong distributional assumptions. Modelling frailty would provide new insight into selection effects and could be extended to include information simultaneously on deaths and the health status of migrants. Chapter II, for example, examined whether and how health status influenced the likelihood of migrants remigrating. This analysis could be extended further by directly linking equations on mortality and health-related return migration to explicitly measure the effect of health-selective return migration on mortality differences between immigrants and the host population.

6.5. Policy implications

First, immigrants experience a migrant mortality advantage relative to the host population in England and Wales which is driven primarily by low mortality from chronic diseases. Chronic diseases are responsible for seven of every ten deaths in England and Wales (ONS, 2014). If culture-specific lifestyle and behavioural factors among migrants operate to reduce the risk for chronic diseases, further insight into migrant's health behaviours could help inform policies to prevent and manage chronic diseases among the England and Wales-born. Second, despite low overall mortality, some migrant groups had high mortality from specific causes of death. It is important for policymakers to be aware of this masking effect. More culturally-aware services could be implemented to help address high disease prevalence in some groups. For example, among South Asians, who have high cardiovascular and diabetes mortality which is linked to genetic susceptibility and enhanced by interactions between genes and the environment, ethnic-specific measures of obesity should be adopted, alongside targeted interventions to promote a better diet and regular exercise. This is particularly important when South Asians have a higher risk of CVD at lower weight levels relative to the England and Wales population (Gupta et al., 2006).

Third, the thesis has shown that most immigrant populations do not emigrate when they become ill. England and Wales has a growing foreign-born population (14% in 2011) (Smith, 2011). Migrants both contribute to and mitigate population ageing (Shaw, 2001) and many of those who moved to work (or to be reunified with family) in England and Wales during the post-war migration era have reached old ages. Consequently, as Norredam et al (2014) recommended after conducting a similar study in Denmark, the healthcare system in England and Wales needs to be arranged to include culturally sensitive services (as alluded to above), particularly with a growing and ageing immigrant population which will stay in England and Wales on becoming ill. Finally, the descendants of immigrants, despite sharing a similar sociocultural background to their relatives, do not experience a migrant mortality advantage. Policymakers should seek to understand why this is the case and look to address this abrupt intergenerational change in mortality.

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Appendix A: Introduction

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Table A1. Calculations for mortality in ONS LS relative to Human Mortality Database (Figure 3) (raw and relative rates).

Age	1971-81			1981-91			1991-01			2001-11		
years	LS	HMD	95% CI	LS	HMD	95% CI	LS	HMD	95% CI	LS	HMD	95% CI
20-24	0.00057	0.00072	0.00051 - 0.00065	0.00063	0.00061	0.00056 - 0.00070	0.00064	0.00062	0.00055 - 0.00074	0.00049	0.00051	0.00042 - 0.00057
25-29	0.00063	0.00071	0.00056 - 0.00071	0.00067	0.00063	0.00060 - 0.00075	0.00063	0.00066	0.00055 - 0.00072	0.00055	0.00059	0.00048 - 0.00063
30-34	0.00089	0.00089	0.00080 - 0.00098	0.00083	0.00079	0.00075 - 0.00092	0.00075	0.00080	0.00066 - 0.00085	0.00076	0.00077	0.00068 - 0.00085
35-39	0.00122	0.00138	0.00111 - 0.00135	0.00107	0.00114	0.00098 - 0.00117	0.00102	0.00110	0.00091 - 0.00113	0.00110	0.00105	0.00101 - 0.00121
40-44	0.00216	0.00241	0.00201 - 0.00233	0.00179	0.00189	0.00166 - 0.00193	0.00163	0.00170	0.00150 - 0.00178	0.00160	0.00155	0.00149 - 0.00173
45-49	0.00401	0.00431	0.00380 - 0.00423	0.00303	0.00336	0.00286 - 0.00322	0.00247	0.00270	0.00230 - 0.00265	0.00244	0.00241	0.00229 - 0.00260
50-54	0.00689	0.00725	0.00662 - 0.00718	0.00522	0.00584	0.00497 - 0.00547	0.00404	0.00450	0.00382 - 0.00428	0.00397	0.00383	0.00378 - 0.00418
55-59	0.01139	0.01159	0.01104 - 0.01177	0.00933	0.01011	0.00900 - 0.00967	0.00701	0.00760	0.00670 - 0.00734	0.00621	0.00597	0.00595 - 0.00647
60-64	0.01830	0.01857	0.01783 - 0.01878	0.01597	0.01655	0.01554 - 0.01642	0.01182	0.01296	0.01140 - 0.01226	0.00960	0.00961	0.00926 - 0.00994
65-69	0.02925	0.02948	0.02862 - 0.02988	0.02523	0.02598	0.02466 - 0.02583	0.02002	0.02186	0.01945 - 0.02060	0.01618	0.01564	0.01571 - 0.01668
70-74	0.04561	0.04651	0.04474 - 0.04650	0.03985	0.04110	0.03906 - 0.04066	0.03346	0.03520	0.03269 - 0.03425	0.02546	0.02603	0.02482 - 0.02612
75-79	0.07085	0.07236	0.06955 - 0.07218	0.06252	0.06396	0.06141 - 0.06365	0.05390	0.05537	0.05278 - 0.05503	0.04246	0.04427	0.04144 - 0.04351
80-84	0.11008	0.11285	0.10795 - 0.11226	0.09866	0.10037	0.09690 - 0.10045	0.08507	0.08915	0.08336 - 0.08681	0.06757	0.07436	0.06513 - 0.07010
85-89	0.17106	0.17486	0.16711 - 0.17510	0.15057	0.15560	0.14740 - 0.15382	0.13805	0.14087	0.13513 - 0.14103	0.12365	0.12448	0.11934 - 0.12652
90+	0.26710	0.26168	0.25912 - 0.27533	0.24952	0.23731	0.24304 - 0.25617	0.23822	0.22175	0.23241 - 0.24418	0.21062	0.20655	0.20400 - 0.21658

Age	1971-81			1981-91			1991-01			2001-11		
years	LS	HMD	95% CI	LS	HMD	95% CI	LS	HMD	95% CI	LS	HMD	95% CI
20-24	0.80	1.00	*0.70 - 0.91*	1.02	1.00	*0.91 - 1.15*	1.03	1.00	*0.90 - 1.20*	0.97	1.00	*0.83 - 1.12*
25-29	0.89	1.00	*0.79 - 1.01*	1.06	1.00	*0.95 - 1.19*	0.95	1.00	*0.83 - 1.09*	0.94	1.00	*0.81 - 1.08*
30-34	1.00	1.00	*0.90 - 1.11*	1.05	1.00	*0.95 - 1.16*	0.93	1.00	*0.82 - 1.06*	0.99	1.00	*0.89 - 1.11*
35-39	0.89	1.00	*0.81 - 0.98*	0.94	1.00	*0.86 - 1.03*	0.92	1.00	*0.83 - 1.03*	1.05	1.00	*0.96 - 1.15*
40-44	0.90	1.00	*0.84 - 0.97*	0.95	1.00	*0.88 - 1.02*	0.96	1.00	*0.88 - 1.05*	1.04	1.00	*0.96 - 1.12*
45-49	0.93	1.00	*0.88 - 0.98*	0.90	1.00	*0.85 - 0.96*	0.91	1.00	*0.85 - 0.98*	1.01	1.00	*0.95 - 1.08*
50-54	0.95	1.00	*0.91 - 0.99*	0.89	1.00	*0.85 - 0.94*	0.90	1.00	*0.85 - 0.95*	1.04	1.00	*0.99 - 1.09*
55-59	0.98	1.00	*0.95 - 1.02*	0.92	1.00	*0.89 - 0.96*	0.92	1.00	*0.88 - 0.97*	1.04	1.00	*1.00 - 1.08*
60-64	0.99	1.00	*0.96 - 1.01*	0.97	1.00	*0.94 - 0.99*	0.91	1.00	*0.88 - 0.95*	1.00	1.00	*0.96 - 1.03*
65-69	0.99	1.00	*0.97 - 1.01*	0.97	1.00	*0.95 - 0.99*	0.92	1.00	*0.89 - 0.94*	1.03	1.00	*1.00 - 1.07*
70-74	0.98	1.00	*0.96 - 1.00*	0.97	1.00	*0.95 - 0.99*	0.95	1.00	*0.93 - 0.97*	0.98	1.00	*0.95 - 1.00*
75-79	0.98	1.00	*0.96 - 1.00*	0.98	1.00	*0.96 - 1.00*	0.97	1.00	*0.95 - 0.99*	0.96	1.00	*0.94 - 0.98*
80-84	0.98	1.00	*0.96 - 0.99*	0.98	1.00	*0.97 - 1.00*	0.95	1.00	*0.93 - 0.97*	0.91	1.00	*0.88 - 0.94*
85-89	0.98	1.00	*0.96 - 1.00*	0.97	1.00	*0.95 - 0.99*	0.98	1.00	*0.96 - 1.00*	0.99	1.00	*0.96 - 1.02*
90+	1.02	1.00	*0.99 - 1.05*	1.05	1.00	*1.02 - 1.08*	1.07	1.00	*1.05 - 1.10*	1.02	1.00	*0.99 - 1.05*

Source: author's calculations based on ONS LS

Table A2. Categorisation of country of birth across censuses, 1971-2011.

Group	1971 Census	1981 Census	1991 Census	2001 Census	2011 Census
England and Wales	England Wales	England Wales	England Wales	England Wales	England Wales
Scotland	Scotland	Scotland	Scotland	Scotland	Scotland
Republic of Ireland	Republic of Ireland	Republic of Ireland	Republic of Ireland	Republic of Ireland	Republic of Ireland
Northern Ireland	Northern Ireland	Northern Ireland	Northern Ireland	Northern Ireland	Northern Ireland
India	India	India	India	India	India
Pakistan	Pakistan/Bangladesh	Pakistan	Pakistan	Pakistan	Pakistan
Bangladesh		Bangladesh	Bangladesh	Bangladesh	Bangladesh
Jamaica	Jamaica	Jamaica	Jamaica	Jamaica	Jamaica
Other Caribbean	Barbados** CW America Trin & Tobago***	Barbados*** Caribbean Mauritius Other Caribbean* Seychelles** Trin & Tobago**** West Indies*****	Barbados*** Caribbean Not Stated* Dependent Territories Mauritius** New Commonwealth Seychelles Trin and Tobago**** West Indies*****	Anguilla Antigua Bahamas Barbados*** Barbuda Bermuda British Virgin Islands Cayman Islands Curacao Dominica Dominican Republic Grenada**** Guadeloupe Haiti Martinique Mauritius* Montserrat Netherland Antilles Seychelles St. Helena St. Kitts and Nevis St. Lucia***** St. Vincent Trinidad and Tobago** West Indies	Anguila Antigua & Barbuda Aruba Bahamas Barbados*** Bermuda British Virgin Islands Caribbean Not Stated Cayman Islands Dominica Dominican Republic Grenada**** Guadeloupe***** Haiti Martinique Mauritius* Montserrat Netherland Antilles Seychelles St. Helena St. Kitts and Nevis St. Lucia St. Vincent Trinidad and Tobago** West Indies
East and South Africa	Kenya* Malawi Rhodesia**** Tanzania** Uganda*** Zambia****	Botswana Kenya* Malawi Tanzania*** Uganda** Zambia***** Zimbabwe****	Botswana, Lesotho and Swaziland Kenya* Malawi Tanzania*** Uganda** Zambia**** Zimbabwe****	Africa East Angola Botswana Burundi Cabinda Comoros Congo Djibouti DR Congo Eritrea Ethiopia Kenya* Lesotho Madagascar Malawi Mozambique Namibia Reunion Rwanda Somalia*** Swaziland Tanzania***** Uganda** Zambia Zimbabwe****	Africa East Angola Botswana Burundi Cabinda Comoros Congo Djibouti DR Congo Eritrea Ethiopia Kenya* Lesotho Madagascar Malawi Mozambique Namibia Reunion Rwanda Somalia** Swaziland Tanzania***** Uganda**** Zambia Zimbabwe***

Group	1971 Census	1981 Census	1991 Census	2001 Census	2011 Census
West and Central Africa	Ghana*** Nigeria* CWAfrica** Sierra Leone****	Gambia***** Ghana*** Nigeria* Other Africa** Sierra Leone****	Gambia***** Ghana*** Nigeria* Other Africa** Sierra Leone****	Africa Not Stated*** Africa West Burkina Faso Cameroon Cape Verde Central African Rep Chad Gabon Gambia**** Ghana** Guinea Guinea-Bisseau Ivory Coast Liberia***** Mali Mauritiana Niger Nigeria* Senegal Sierra Leone Togo	Africa Not Stated Benin Burkina Cameroon Cape Verde Central African Rep Chad Equatorial Guinea French Polynesia Gabon Gambia Ghana** Guinea Guinea-Bisseau Ivory Coast Liberia Mali Mauritiana Niger Nigeria* Sao Tome & Principe Senegal Sierra Leone*** Togo
China	China Hong Kong	China Hong Kong	China Hong Kong	China Hong Kong Macao	China Hong Kong Macao
Other Asia	Burma*** Ceylon** Malaysia/Singapore* Other Asian	Burma*** Japan***** Malaysia/Singapore* Phillipines/Vietnam** Sri Lanka****	Asia - Not Stated Burma Japan***** Malaysia* Phillipines/Vietnam*** Singapore*** Sri Lanka** Taiwan Thailand	Asia Not Stated Bhutan Brunei Cambodia Indonesia Japan Java Laos Malaysia** Maldives Mongolia Myanmar Nepal Oman Papua New Guinea Phillipines*** Singapore**** South Korea Sri Lanka* Taiwan Thailand Tibet Vietnam****	Asia Not Stated Bhutan Brunei Burma Cambodia East Timor Indonesia Japan Laos Malaysia*** Maldives Mongolia Nepal**** North Korea Papua New Guinea Phillipines** Singapore South Korea Sri Lanka* Taiwan Thailand Tibet Vietnam*****
Western Europe	Austria Belgium Cyprus** France***** Germany* Gibraltar Italy*** Malta and Gozo	Austria Belgium Cyprus** France***** Germany* Gibraltar Italy*** Malta and Gozo	Austria Belgium Cyprus** France**** Germany* Gibraltar Italy*** Luxemborg	Austria Belgium Canary Islands Cyprus*** France**** Germany* Gibraltar Ibiza	Andorra Austria Belgium Canary Islands Cyprus***** France*** Germany* Gibraltar

Group	1971 Census	1981 Census	1991 Census	2001 Census	2011 Census
Western Europe	Netherlands Spain****	Netherlands Portugal Spain**** Switzerland	Malta and Gozo Netherlands Portugal Spain***** Switzerland	Italy** Luxemborg Malta and Gozo Netherlands Portugal Spain***** Switzerland	Italy** Luxemborg Malta Monaco Netherlands Portugal**** Spain Switzerland
Eastern Europe	Hungary**** Other Europe** Poland* USSR***	Albania Czechoslovakia***** Greece Hungary**** Other Europe Poland* Romania USSR** Yugoslavia***	Albania Bulgaria Czechoslovakia***** Greece**** Hungary Other Europe Poland* Romania USSR** Yugoslavia***	Albania Belarus Bosnia & Herzegovina Bulgaria Croatia Czech Republic Estonia Georgia Greece Hungary***** Latvia Lithuania Macedonia Moldova Montenegro Other Europe Poland* Romania Russia*** Russian Indep States Serbia Slovakia Slovenia Ukraine** Yugoslavia****	Albania Belarus Bosnia & Herzegovina Bulgaria Croatia Czech Republic Estonia Europe Not Stated Georgia Greece Hungary Lativa**** Lithuania** Macedonia Moldova Montenegro Poland* Romania*** Russia Serbia Serbia & Montenegro Slovakia***** Soviet Socialist Rep Turkmenistan Ukraine Yemen Yugoslavia
Rest of the World	Australia*** Canada** Guyana Iran Israel Latin America New Zealand***** Not stated South Africa**** Turkey USA*	Algeria Australia** Belize Canada*** Central America Denmark Egypt Finland Greenland Guyana Iran***** Israel Libya Middle East Morocco New Zealand**** Norway Not stated South Africa South America Tunisia Turkey USA*	Algeria Australia** Belize Brazil Canada Central America Columbia Denmark Egypt Finland Guyana Iran Iraq Israel Jordan Lebanon Libya Middle East Morocco New Zealand Norway Not Stated Saudi Arabia South Africa***	Abu Dhabi Aden Afghanistan Africa North Algeria Argentina Armenia Ascension Island Australia*** Azerbaijan Azores Bahrain Belize Bolivia Brazil Canada**** Chile Columbia Cook Islands Costa Rica Cuba Denmark Dubai Ecuador	Afghanistan Algeria Antarctica Argentina Armenia Australia*** Azerbaijan Bahrain Belize Bolivia Brazil British Indian Territory Canada**** Chile Colombia Cook Islands Costa Rica Cuba Denmark Ecuador Egypt El Salvador Faroe Islands Fiji

Group	1971 Census	1981 Census	1991 Census	2001 Census	2011 Census
Rest of the World			South America	Egypt	Finland
			Sweden	El Salvador	French Guiana
			Syria	Fiji	Guam
			Tunisia	Finland	Guatemala
			Turkey	French Guiana	Guyana
			USA*	Guam	Haiti
				Guatemala	Honduras
				Guyana	Iceland
				Honduras	Iran
				Iceland	Iraq*****
				Iran	Israel
				Iraq	Jordan
				Israel	Kazakhstan
				Jordan	Kiribati
				Kashmir	Kosovo
				Kazakhstan	Kuwait
				Kiribati	Kyrgyztan
				Kosovo	Lebanon
				Kuwait	Libya
				Kyrgyztan	Mayotte
				Lebanon	Mexico
				Libya	Middle East Not Stated
				Melilla	Morocco
				Mexico	New Caledonia
				Middle East	New Zealand
				Morocco	Nicaragua
				New Caledonia	Norway
				New Zealand	Not Stated
				Norfolk Island	Not Stated
				Norway	Omar
				Not Stated	Palestine
				Palestine	Panama
				Panama	Paraguay
				Paraguay	Peru
				Peru	Puerto Rico
				Puerta Rico	Qatar
				Qatar	S America Not Stated
				Saudi Arabia	Samoa
				Sharjah	Saudi Arabia
				South Africa**	Solomon Islands
				South America	South Africa**
				Sudan	Sudan
				Suriname	Surinam
				Sweden	Sweden
				Syria	Syria
				Tajikistan	Tajikstan
				Tongo	Tonga
				Tunisia	Tunisia
				Turkey****	Turkey
				United Arab Emirates	United Arab Emirates
				Uruguay	Uruguay
				USA*	USA*
				Uzbekistan	Uzbekistan
				Vanuatu	Vanuatu
				Venezuela	Venezula
				Yemen	Yemen

Note: * to * defines the top five sending countries in larger groups (* 1st to **** 5th)***
CW America (Commonwealth America) and CW Africa (Commonwealth Africa)

Source: author's calculations based on ONS LS

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Appendix B: Chapter I

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Table B1. Model 1 from Chapter I with log relative hazard, standard errors, z-score and p-values (sex-adjusted).[30]

	Model 1														
	Early exit [2-years]					Middle exit [4-years]					Late exit [7-years)				
	Log Haz	S.E	Z-score	P-value	Haz Ratio	Log Haz	S.E	Z-score	P-value	Haz Ratio	Log Haz	S.E	Z-score	P-value	Haz Ratio
Sex															
Male	**0**				**1**	**0**				**1**	**0**				**1**
Female	-0.50	0.01	-39.79	*0.00*	0.61	-0.50	0.01	-39.76	*0.00*	0.61	-0.50	0.01	-39.69	*0.00*	0.61
Period															
1971-1981	**0**				**1**	**0**				**1**	**0**				**1**
1981-1991	-0.09	0.02	-4.13	*0.00*	0.91	-0.10	0.02	-4.39	*0.00*	0.91	-0.10	0.02	-4.73	*0.00*	0.90
1991-2001	-0.14	0.02	-6.15	*0.00*	0.87	-0.15	0.02	-6.84	*0.00*	0.86	-0.17	0.02	-7.83	*0.00*	0.84
Country of birth															
England and Wales	**0**				**1**	**0**				**1**	**0**				**1**
Scotland	0.26	0.05	6.66	*0.00*	1.30	0.25	0.05	6.38	*0.00*	1.28	0.23	0.05	5.85	*0.00*	1.26
Northern Ireland	0.25	0.09	3.58	*0.00*	1.28	0.24	0.09	3.46	*0.00*	1.27	0.22	0.09	3.24	*0.00*	1.25
Irish Republic	0.21	0.05	5.36	*0.00*	1.24	0.20	0.05	4.96	*0.00*	1.22	0.17	0.05	4.23	*0.00*	1.18
India	0.00	0.04	-0.08	*0.94*	1.00	-0.02	0.04	-0.44	*0.66*	0.98	-0.05	0.04	-1.09	*0.28*	0.95
Pakistan	-0.14	0.07	-1.82	*0.07*	0.87	-0.16	0.06	-2.14	*0.03*	0.85	-0.21	0.06	-2.73	*0.01*	0.81
Bangladesh	-0.16	0.10	-1.34	*0.18*	0.85	-0.19	0.10	-1.59	*0.11*	0.83	-0.24	0.09	-2.03	*0.04*	0.79
Jamaica	0.12	0.08	1.74	*0.08*	1.13	0.09	0.07	1.31	*0.19*	1.09	0.04	0.07	0.55	*0.58*	1.04
Other Caribbean	-0.07	0.09	-0.72	*0.47*	0.93	-0.10	0.09	-1.05	*0.29*	0.90	-0.16	0.08	-1.64	*0.10*	0.86
East and South Africa	-0.11	0.08	-1.15	*0.25*	0.90	-0.12	0.08	-1.27	*0.20*	0.89	-0.14	0.08	-1.51	*0.13*	0.87
West and Central Africa	-0.01	0.14	-0.09	*0.93*	0.99	-0.05	0.13	-0.39	*0.70*	0.95	-0.13	0.12	-0.93	*0.35*	0.88
Western Europe	-0.33	0.05	-5.04	*0.00*	0.72	-0.35	0.05	-5.31	*0.00*	0.70	-0.38	0.05	-5.79	*0.00*	0.68
Eastern Europe	0.04	0.07	0.62	*0.54*	1.05	0.03	0.07	0.45	*0.65*	1.03	0.01	0.07	0.19	*0.85*	1.01
China	-0.15	0.13	-1.05	*0.29*	0.86	-0.18	0.12	-1.24	*0.22*	0.83	-0.23	0.12	-1.57	*0.12*	0.80
Other Asia	-0.30	0.09	-2.50	*0.01*	0.74	-0.33	0.09	-2.70	*0.01*	0.72	-0.37	0.08	-3.06	*0.00*	0.69
Rest of World	-0.02	0.05	-0.34	*0.73*	0.98	-0.04	0.05	-0.85	*0.40*	0.96	-0.09	0.05	-1.77	*0.08*	0.91
Unresolvable	0.72	0.19	7.97	*0.00*	2.06	0.69	0.18	7.59	*0.00*	1.99	0.62	0.17	6.90	*0.00*	1.87

Source: author's calculations based on ONS LS

[30] Early (constant) **0.00000459**; (SE) **0.000000145**; (z-score) **-389.53**; (p-value) **0.00**; Early (gamma) **0.007712**; (SE) **0.0000508**; (z-score) **151.80**; (p-value) **0.00**; Middle (constant) **0.00000447**; (SE) **0.000000141**; (z-score) **-390.27**; (p-value) **0.00**; Middle (gamma) **0.007756**; (SE) **0.0000508**; (z-score) **152.70**; (p-value) **0.00;** Late (constant) **0.00000434**; (SE) **0.000000137**; (z-score) **-391.47**; (p-value) **0.00**; Late (gamma) **0.007721**; (SE) **0.0000507**; (z-score) **153.89**; (p-value) **0.00**

Table B2. Models 2 and 3 from Chapter I with log relative hazard, standard errors, z-score and p-values (sex-adjusted)[31]

	Model 2 (entry adjustment)					**Model 3 (SES)**				
	Log Haz	S.E	Z-score	P-value	Haz Ratio	Log Haz	S.E	Z-score	P-value	Haz Ratio
Sex										
Male	**0**				**1**	**0**				**1**
Female	-0.50	0.01	-39.57	*0.00*	0.61	-0.72	0.01	-52.11	*0.00*	0.49
Period										
1971-1981	**0**				**1**	**0**				**1**
1981-1991	-0.10	0.02	-4.73	*0.00*	0.90	-0.08	0.02	-3.48	*0.00*	0.92
1991-2001	-0.16	0.02	-7.06	*0.00*	0.85	-0.12	0.02	-5.35	*0.00*	0.88
Country of birth										
England and Wales	**0**				**1**	**0**				**1**
Scotland	0.26	0.05	6.63	*0.00*	1.29	0.25	0.05	6.43	*0.00*	1.28
Northern Ireland	0.27	0.09	3.88	*0.00*	1.31	0.19	0.08	2.81	*0.01*	1.22
Irish Republic	0.21	0.05	5.44	*0.00*	1.24	0.10	0.04	2.58	*0.01*	1.11
India	0.04	0.05	0.87	*0.38*	1.04	-0.12	0.04	-2.70	*0.01*	0.89
Pakistan	-0.09	0.07	-1.14	*0.26*	0.92	-0.38	0.05	-5.00	*0.00*	0.69
Bangladesh	-0.06	0.11	-0.51	*0.61*	0.94	-0.49	0.07	-4.08	*0.00*	0.62
Jamaica	0.10	0.08	1.47	*0.14*	1.11	-0.03	0.07	-0.51	*0.61*	0.97
Other Caribbean	-0.08	0.09	-0.79	*0.43*	0.93	-0.16	0.08	-1.72	*0.09*	0.85
East and South Africa	0.00	0.09	-0.01	*0.99*	1.00	-0.20	0.08	-2.16	*0.03*	0.82
West and Central Africa	0.10	0.15	0.69	*0.49*	1.10	-0.18	0.12	-1.26	*0.21*	0.84
Western Europe	-0.32	0.05	-4.79	*0.00*	0.73	-0.38	0.05	-5.77	*0.00*	0.68
Eastern Europe	0.07	0.08	0.94	*0.35*	1.07	-0.04	0.07	-0.54	*0.59*	0.96
China	-0.08	0.13	-0.57	*0.57*	0.92	-0.29	0.11	-2.01	*0.05*	0.75
Other Asia	-0.20	0.10	-1.62	*0.11*	0.82	-0.38	0.08	-3.16	*0.00*	0.68
Rest of World	0.04	0.05	0.74	*0.46*	1.04	-0.12	0.05	-2.23	*0.03*	0.89
Unresolvable	0.72	0.19	8.00	*0.00*	2.06	0.48	0.15	5.28	*0.00*	1.61
Education level										
High						**0**				**1**
Middle						0.18	0.05	3.95	*0.00*	1.19
Low						0.45	0.06	12.36	*0.00*	1.57
Unspecified						0.59	0.17	6.32	*0.00*	1.81
Missing						1.14	0.13	28.41	*0.00*	3.13
Social Class	*(Socioeconomic characteristics not adjusted for)*									
Upper						**0**				**1**
Middle						0.19	0.02	9.92	*0.00*	1.21
Lower						0.42	0.05	14.04	*0.00*	1.52
Unspecified						0.79	0.05	35.63	*0.00*	2.20
Missing						*(Omitted)*				

Source: author's calculations based on ONS LS

[31] Entry (constant) **0.00000461**; (SE) **0.000000145**; (z-score) **-389.09**; (p-value) **0.00**; Entry (gamma) **0.007721**; (SE) **0.0000509**; (z-score) **151.72**; (p-value) **0.00**; SES (constant) **0.00000239**; (SE) **0.000000108**; (z-score) **-285.42**; (p-value) **0.00**; SES (gamma) **0.007693**; (SE) **0.0000499**; (z-score) **154.04**; (p-value) **0.00**

Table B3. Model 4 from Chapter I with log relative hazard, standard errors, z-score and p-values (sex-stratified)[32]

Model 4	**Males**					**Females**				
	Log Haz	S.E	Z-score	P-value	Haz Ratio	Log Haz	S.E	Z-score	P-value	Haz Ratio
Period										
1971-1981	**0**				**1**	**0**				**1**
1981-1991	-0.09	0.03	-2.45	*0.01*	0.91	-0.10	0.03	-3.37	*0.00*	0.91
1991-2001	-0.10	0.03	-2.72	*0.01*	0.90	-0.19	0.02	-6.66	*0.00*	0.82
Country of birth										
England and Wales	**0**				**1**	**0**				**1**
Scotland	0.30	0.09	4.69	*0.00*	1.35	0.22	0.06	4.50	*0.00*	1.25
Northern Ireland	0.19	0.14	1.61	*0.11*	1.20	0.19	0.11	2.19	*0.03*	1.21
Irish Republic	0.13	0.07	2.06	*0.04*	1.14	0.06	0.05	1.22	*0.22*	1.06
India	-0.17	0.07	-2.17	*0.03*	0.84	-0.11	0.05	-2.05	*0.04*	0.90
Pakistan	-0.41	0.10	-2.80	*0.01*	0.66	-0.39	0.06	-4.36	*0.00*	0.68
Bangladesh	-0.52	0.15	-2.06	*0.04*	0.60	-0.52	0.08	-3.87	*0.00*	0.59
Jamaica	0.29	0.13	2.91	*0.00*	1.34	-0.29	0.07	-3.11	*0.00*	0.75
Other Caribbean	-0.03	0.15	-0.18	*0.86*	0.97	-0.26	0.09	-2.18	*0.03*	0.77
East and South Africa	-0.04	0.14	-0.29	*0.77*	0.96	-0.33	0.09	-2.69	*0.01*	0.72
West and Central Africa	-0.39	0.20	-1.29	*0.20*	0.68	-0.14	0.14	-0.88	*0.38*	0.87
Western Europe	-0.43	0.06	-4.68	*0.00*	0.65	-0.33	0.07	-3.42	*0.00*	0.72
Eastern Europe	-0.09	0.11	-0.72	*0.47*	0.92	-0.04	0.08	-0.40	*0.69*	0.97
China	-0.66	0.17	-1.98	*0.05*	0.52	-0.18	0.14	-1.12	*0.26*	0.83
Other Asia	-0.35	0.13	-1.91	*0.06*	0.70	-0.45	0.10	-2.81	*0.01*	0.64
Rest of World	-0.16	0.07	-1.93	*0.05*	0.85	-0.10	0.06	-1.54	*0.12*	0.90
Unresolvable	0.71	0.28	5.09	*0.00*	2.03	0.30	0.16	2.53	*0.01*	1.35
Education level										
High	**0**				**1**	**0**				**1**
Middle	0.09	0.09	1.00	*0.32*	1.09	0.18	0.06	3.27	*0.00*	1.19
Low	0.41	0.11	5.33	*0.00*	1.50	0.45	0.06	10.79	*0.00*	1.56
Unspecified	0.75	0.32	4.90	*0.00*	2.12	0.36	0.17	2.98	*0.00*	1.43
Missing	1.02	0.23	12.39	*0.00*	2.78	1.15	0.15	24.84	*0.00*	3.17
Social Class										
Upper	**0**				**1**	**0**				**1**
Middle	0.09	0.04	2.40	*0.02*	1.10	0.21	0.03	9.43	*0.00*	1.24
Lower	0.24	0.07	4.62	*0.00*	1.27	0.47	0.06	12.81	*0.00*	1.60
Unspecified	0.51	0.06	13.61	*0.00*	1.67	1.07	0.08	37.54	*0.00*	2.92
Missing	*(Omitted)*					*(Omitted)*				

Source: author's calculations based on ONS LS

[32] Male (constant) **0.00000139**; (SE) **0.000000122**; (z-score) **-153.92**; (p-value) **0.00**; Male (gamma) **0.007734**; (SE) **0.0000824**; (z-score) **93.82**; (p-value) **0.00**; Female (constant) **0.00000232**; (SE) **0.000000125**; (z-score) **-240.90**; (p-value) **0.00**; Female (gamma) **0.007743**; (SE) **0.0000627**; (z-score) **123.48**; (p-value) **0.00**

Table B4. Additional sensitivity models: Exits for 'lost to follow-up' 5- and 8-years after census.[33]

Additional sensitivity models	Exits after census									
	5-year					8-year				
	Log Haz	S.E	Z-score	P-value	Haz Ratio	Log Haz	S.E	Z-score	P-value	Haz Ratio
Sex										
Male	**0**				**1**	**0**				**1**
Female	-0.50	0.01	-39.74	*0.00*	0.61	-0.50	0.01	-39.66	*0.00*	0.61
Period										
1971-1981	**0**				**1**	**0**				**1**
1981-1991	-0.10	0.02	-4.51	*0.00*	0.91	-0.11	0.02	-4.82	*0.00*	0.90
1991-2001	-0.16	0.02	-7.18	*0.00*	0.85	-0.18	0.02	-8.13	*0.00*	0.83
Country of birth										
England and Wales	**0**				**1**	**0**				**1**
Scotland	0.24	0.05	6.21	*0.00*	1.27	0.22	0.05	5.64	*0.00*	1.25
Northern Ireland	0.24	0.09	3.39	*0.00*	1.27	0.22	0.09	3.16	*0.00*	1.24
Irish Republic	0.19	0.05	4.73	*0.00*	1.20	0.16	0.05	3.96	*0.00*	1.17
India	-0.03	0.04	-0.64	*0.52*	0.97	-0.06	0.04	-1.34	*0.18*	0.94
Pakistan	-0.18	0.06	-2.32	*0.02*	0.84	-0.22	0.06	-2.96	*0.00*	0.80
Bangladesh	-0.21	0.10	-1.73	*0.08*	0.81	-0.26	0.09	-2.21	*0.03*	0.77
Jamaica	0.07	0.07	1.07	*0.29*	1.08	0.02	0.07	0.27	*0.79*	1.02
Other Caribbean	-0.12	0.08	-1.24	*0.22*	0.89	-0.18	0.08	-1.86	*0.06*	0.84
East and South Africa	-0.13	0.08	-1.34	*0.18*	0.88	-0.15	0.08	-1.60	*0.11*	0.86
West and Central Africa	-0.08	0.13	-0.56	*0.58*	0.92	-0.16	0.12	-1.14	*0.26*	0.85
Western Europe	-0.36	0.05	-5.46	*0.00*	0.70	-0.40	0.04	-5.98	*0.00*	0.67
Eastern Europe	0.03	0.07	0.37	*0.71*	1.03	0.01	0.07	0.09	*0.93*	1.01
China	-0.20	0.12	-1.34	*0.18*	0.82	-0.25	0.11	-1.70	*0.09*	0.78
Other Asia	-0.34	0.09	-2.81	*0.01*	0.71	-0.39	0.08	-3.21	*0.00*	0.68
Rest of World	-0.06	0.05	-1.13	*0.26*	0.94	-0.11	0.05	-2.13	*0.03*	0.90
Unresolvable	0.67	0.18	7.37	*0.00*	1.95	0.60	0.16	6.64	*0.00*	1.82

Source: author's calculations based on ONS LS

[33] 5-year (constant) **0.00000442**; (SE) **0.00000014**; (z-score) **-390.66**; (p-value) **0.00**; 5-year (gamma) **0.007776**; (SE) **0.0000508**; (z-score) **153.13**; (p-value) **0.00**; 8-year (constant) **0.00000430**; (SE) **0.000000136**; (z-score) **-391.92**; (p-value) **0.00**; 8-year (gamma) **0.007821**; (SE) **0.0000507**; (z-score) **154.24**; (p-value) **0.00**

Table B5. Hazard ratios for mortality among immigrants excluding LS members who are 'lost to follow-up'.[34]

No LTFU	Log Haz	S.E	Z-score	P-value	Haz Ratio
Sex					
Male	**0**				**1**
Female	-0.50	0.01	-39.90	*0.00*	0.60
Period					
1971-1981	**0**				**1**
1981-1991	-0.09	0.02	-4.19	*0.00*	0.91
1991-2001	-0.17	0.02	-7.71	*0.00*	0.84
Country of birth					
England and Wales	**0**				**1**
Scotland	0.29	0.05	7.36	*0.00*	1.33
Northern Ireland	0.27	0.09	3.92	*0.00*	1.31
Republic of Ireland	0.26	0.05	6.61	*0.00*	1.30
India	0.05	0.05	1.02	*0.31*	1.05
Pakistan	-0.05	0.07	-0.72	*0.47*	0.95
Bangladesh	-0.07	0.11	-0.58	*0.56*	0.93
Jamaica	0.21	0.08	3.13	*0.00*	1.24
Other Caribbean	0.03	0.10	0.35	*0.73*	1.03
East and South Africa	-0.07	0.09	-0.75	*0.45*	0.93
West and Central Africa	0.08	0.15	0.55	*0.58*	1.08
Western Europe	-0.29	0.05	-4.31	*0.00*	0.75
Eastern Europe	0.08	0.08	1.05	*0.29*	1.08
China	-0.09	0.13	-0.61	*0.54*	0.91
Other Asia	-0.24	0.09	-2.02	*0.04*	0.78
Rest of the World	0.05	0.05	0.91	*0.36*	1.05
Indeterminable	0.88	0.22	9.70	*0.00*	2.40

Source: author's calculations based on ONS LS

[34] Basic (constant) **0.00000512**; (SE) **0.000000162**; (z-score) **-385.53**; (p-value) **0.00**; Basic (gamma) **0.007608**; (SE) **0.0000508**; (z-score) **149.72**; (p-value) **0.00**

Table B6. Hazard ratios for mortality among immigrants using the conservative scenario (entry at census; 2-year exit if 'lost to follow-up').[35]

Extreme scenario	**Basic**					**SES**				
	Log Haz	S.E	Z-score	P-value	Haz Ratio	Log Haz	S.E	Z-score	P-value	Haz Ratio
Sex										
Male	**0**				**1**	**0**				**1**
Female	-0.50	0.01	-39.60	*0.00*	0.61	-0.71	0.01	-51.72	*0.00*	0.49
Period										
1971-1981	**0**				**1**	**0**				**1**
1981-1991	-0.10	0.02	-4.47	*0.00*	0.91	-0.10	0.02	-4.29	*0.00*	0.91
1991-2001	-0.14	0.02	-6.36	*0.00*	0.87	-0.13	0.02	-5.60	*0.00*	0.88
Country of birth										
England and Wales	**0**				**1**	**0**				**1**
Scotland	0.27	0.05	6.92	*0.00*	1.31	0.27	0.05	6.94	*0.00*	1.31
Northern Ireland	0.28	0.09	4.00	*0.00*	1.32	0.24	0.09	3.47	*0.00*	1.27
Republic of Ireland	0.23	0.05	5.86	*0.00*	1.26	0.14	0.05	3.45	*0.00*	1.15
India	0.06	0.05	1.26	*0.21*	1.06	-0.03	0.04	-0.71	*0.48*	0.97
Pakistan	-0.06	0.07	-0.78	*0.43*	0.94	-0.27	0.06	-3.59	*0.00*	0.76
Bangladesh	-0.03	0.12	-0.21	*0.83*	0.97	-0.32	0.09	-2.67	*0.01*	0.73
Jamaica	0.13	0.08	1.91	*0.06*	1.14	-0.01	0.07	-0.13	*0.90*	0.99
Other Caribbean	-0.04	0.09	-0.45	*0.65*	0.96	-0.11	0.09	-1.14	*0.26*	0.90
East and South Africa	0.01	0.10	0.13	*0.89*	1.01	-0.02	0.09	-0.25	*0.80*	0.98
West and Central Africa	0.15	0.16	1.06	*0.29*	1.16	0.07	0.15	0.52	*0.61*	1.08
Western Europe	-0.30	0.05	-4.50	*0.00*	0.74	-0.32	0.05	-4.84	*0.00*	0.73
Eastern Europe	0.08	0.08	1.11	*0.27*	1.08	0.01	0.07	0.20	*0.84*	1.01
China	-0.05	0.14	-0.36	*0.72*	0.95	-0.14	0.13	-0.95	*0.34*	0.87
Other Asia	-0.17	0.10	-1.38	*0.17*	0.85	-0.16	0.10	-1.36	*0.17*	0.85
Rest of the World	0.07	0.05	1.31	*0.19*	1.07	0.02	0.05	0.39	*0.70*	1.02
Indeterminable	0.76	0.19	8.40	*0.00*	2.14	0.53	0.15	5.89	*0.00*	1.71
Education level										
High						**0**				**1**
Low						0.18	0.05	3.91	*0.00*	1.19
Middle						0.46	0.06	12.51	*0.00*	1.58
Unspecified			*(Socioeconomic*			0.56	0.16	6.01	*0.00*	1.76
Missing			*characteristics*			1.27	0.14	31.59	*0.00*	3.56
Social Class			*not adjusted for)*							
Upper						**0**				**1**
Middle						0.19	0.02	9.72	*0.00*	1.21
Lower						0.42	0.05	13.99	*0.00*	1.52
Missing						0.78	0.05	35.37	*0.00*	2.19

Source: author's calculations based on ONS LS

[35] Basic (constant) **0.000004730**; (SE) **0.000000149**; (z-score) **-388.29**; (p-value) **0.00**; Basic (gamma) **0.007674**; (SE) **0.0000509**; (z-score) **150.76**; (p-value) **0.00**; SES (constant) **0.00000254**; (SE) **0.0000001150**; (z-score) **-285.00**; (p-value) **0.00**; SES (gamma) **0.0076066**; (SE) **0.00005**; (z-score) **152.04**; (p-value) **0.00**

Table B7. Age interaction model and reference model with likelihood ratio test (Figure 2 in Chapter I).[36]

	Comparison Model					Interaction Model				
	Log Haz	S.E	Z-score	P-value	Haz Ratio	Log Haz	S.E	Z-score	P-value	Haz Ratio
Country of birth										
UK-born	**0**				**1**	**0**				**1**
South Asian	-0.22	0.03	-6.06	*0.00*	0.80	-0.46	0.11	-4.31	0.00	0.63
Caribbean & African	-0.12	0.04	-2.64	*0.01*	0.89	-0.36	0.11	-3.23	0.00	0.70
Chinese	-0.35	0.07	-3.72	*0.00*	0.71	-0.58	0.13	-4.27	0.00	0.56
Other	-0.12	0.03	-3.48	*0.00*	0.89	-0.36	0.11	-3.31	0.00	0.70
Sex										
Male	**0**				**1**	**0**				**1**
Female	-0.72	0.01	-52.29	*0.00*	0.49	-0.72	0.01	-52.24	0.00	0.49
Period										
1971-1981	**0**				**1**	**0**				**1**
1981-1991	-0.08	0.02	-3.50	*0.00*	0.92	-0.08	0.02	-3.48	0.00	0.92
1991-2001	-0.12	0.02	-5.41	*0.00*	0.88	-0.12	0.02	-5.39	0.00	0.88
Education level										
High	**0**				**1**	**0**				**1**
Middle	0.18	0.05	3.93	*0.00*	1.19	0.18	0.05	3.94	0.00	1.19
Low	0.45	0.06	12.32	*0.00*	1.57	0.45	0.04	12.32	0.00	1.57
Unspecified	0.60	0.17	6.42	*0.00*	1.82	0.60	0.09	6.44	0.00	1.83
Missing	1.14	0.13	28.41	*0.00*	3.13	1.14	0.04	28.44	0.00	3.14
Social Class										
Upper	**0**				**1**	**0**				**1**
Middle	0.19	0.02	9.93	*0.00*	1.21	0.19	0.02	9.91	0.00	1.21
Lower	0.42	0.05	13.98	*0.00*	1.51	0.41	0.03	13.96	0.00	1.51
Unspecified	0.79	0.05	35.67	*0.00*	2.20	0.79	0.02	35.63	0.00	2.20
Missing	*(omitted)*					*(omitted)*				

Source: author's calculations based on ONS LS

Interaction term (immigrants): 0.0003647

Likelihood ratio test (assumption comparison model nested in interaction model)

LR $chi^2(1) = 5.65$; Prob > $chi^2 = 0.0174$

[36] Comparison (constant) **0.00000238**; (SE) **0.000000108**; (z-score) **-286.92**; (p-value) **0.00**; Comparison (gamma) **0.0076991**; (SE) **0.0000498**; (z-score) **154.58**; (p-value) **0.00**; Interaction (constant) **-12.92708**; (SE) **0.0458422**; (z-score) **-281.99**; (p-value) **0.00**; Interaction (gamma – immigrant) **0.0003647**; (SE) **0.0001541**; (z-score) **2.37**; (p-value) **0.005**; Interaction (constant) **0.0076686**; (SE) **0.0000514**; (z-score) **149.23**; (p-value) **0.00**

Table B8. Values used to plot Fig 2 calculated from interaction model (Table 6) above.

Age years	UK-born			South Asian			Caribbean & African			Chinese & Other Asian			European and Other		
	Log Hazard	Hazard Rate	Haz Ratio	Log Hazard	Hazard Rate	Haz Ratio	Log Hazard	Hazard Rate	Haz Ratio	Log Hazard	Hazard Rate	Haz Ratio	Log Hazard	Hazard Rate	Haz Ratio
Start	-10.46	0.0000	1.00	-10.92	0.0000	0.63	-10.82	0.0000	0.70	-11.04	0.0000	0.56	-10.82	0.0000	0.70
20	-8.62	0.0002	1.00	-9.00	0.0001	0.69	-8.89	0.0001	0.76	-9.11	0.0001	0.61	-8.90	0.0001	0.76
21	-8.53	0.0002	1.00	-8.90	0.0001	0.69	-8.80	0.0001	0.77	-9.02	0.0001	0.62	-8.80	0.0002	0.76
22	-8.44	0.0002	1.00	-8.80	0.0002	0.69	-8.70	0.0002	0.77	-8.92	0.0001	0.62	-8.70	0.0002	0.77
23	-8.35	0.0002	1.00	-8.71	0.0002	0.70	-8.60	0.0002	0.77	-8.82	0.0001	0.62	-8.61	0.0002	0.77
24	-8.25	0.0003	1.00	-8.61	0.0002	0.70	-8.51	0.0002	0.78	-8.73	0.0002	0.62	-8.51	0.0002	0.77
25	-8.16	0.0003	1.00	-8.51	0.0002	0.70	-8.41	0.0002	0.78	-8.63	0.0002	0.63	-8.41	0.0002	0.78
26	-8.07	0.0003	1.00	-8.42	0.0002	0.71	-8.32	0.0002	0.78	-8.53	0.0002	0.63	-8.32	0.0002	0.78
27	-7.98	0.0003	1.00	-8.32	0.0002	0.71	-8.22	0.0002	0.79	-8.44	0.0002	0.63	-8.22	0.0003	0.78
28	-7.89	0.0004	1.00	-8.23	0.0003	0.71	-8.12	0.0003	0.79	-8.34	0.0002	0.64	-8.12	0.0003	0.79
29	-7.79	0.0004	1.00	-8.13	0.0003	0.72	-8.03	0.0003	0.79	-8.24	0.0003	0.64	-8.03	0.0003	0.79
30	-7.70	0.0005	1.00	-8.03	0.0003	0.72	-7.93	0.0003	0.80	-8.15	0.0003	0.64	-7.93	0.0004	0.80
31	-7.61	0.0005	1.00	-7.94	0.0004	0.72	-7.83	0.0004	0.80	-8.05	0.0003	0.64	-7.84	0.0004	0.80
32	-7.52	0.0005	1.00	-7.84	0.0004	0.73	-7.74	0.0004	0.80	-7.96	0.0004	0.65	-7.74	0.0004	0.80
33	-7.43	0.0006	1.00	-7.74	0.0004	0.73	-7.64	0.0004	0.81	-7.86	0.0004	0.65	-7.64	0.0005	0.81
34	-7.33	0.0007	1.00	-7.65	0.0005	0.73	-7.54	0.0005	0.81	-7.76	0.0004	0.65	-7.55	0.0005	0.81
35	-7.24	0.0007	1.00	-7.55	0.0005	0.74	-7.45	0.0005	0.81	-7.67	0.0005	0.65	-7.45	0.0006	0.81
36	-7.15	0.0008	1.00	-7.45	0.0006	0.74	-7.35	0.0006	0.82	-7.57	0.0005	0.66	-7.35	0.0006	0.82
37	-7.06	0.0009	1.00	-7.36	0.0006	0.74	-7.25	0.0006	0.82	-7.47	0.0006	0.66	-7.26	0.0007	0.82
38	-6.97	0.0009	1.00	-7.26	0.0007	0.74	-7.16	0.0007	0.83	-7.38	0.0006	0.66	-7.16	0.0008	0.82
39	-6.87	0.0010	1.00	-7.16	0.0008	0.75	-7.06	0.0008	0.83	-7.28	0.0007	0.67	-7.06	0.0009	0.83
40	-6.78	0.0011	1.00	-7.07	0.0009	0.75	-6.97	0.0009	0.83	-7.18	0.0008	0.67	-6.97	0.0009	0.83
41	-6.69	0.0012	1.00	-6.97	0.0009	0.75	-6.87	0.0009	0.84	-7.09	0.0008	0.67	-6.87	0.0010	0.83
42	-6.60	0.0014	1.00	-6.88	0.0010	0.76	-6.77	0.0010	0.84	-6.99	0.0009	0.68	-6.78	0.0011	0.84
43	-6.51	0.0015	1.00	-6.78	0.0011	0.76	-6.68	0.0011	0.84	-6.89	0.0010	0.68	-6.68	0.0013	0.84
44	-6.41	0.0016	1.00	-6.68	0.0013	0.76	-6.58	0.0013	0.85	-6.80	0.0011	0.68	-6.58	0.0014	0.85
45	-6.32	0.0018	1.00	-6.59	0.0014	0.77	-6.48	0.0014	0.85	-6.70	0.0012	0.68	-6.49	0.0015	0.85
46	-6.23	0.0020	1.00	-6.49	0.0015	0.77	-6.39	0.0015	0.85	-6.61	0.0014	0.69	-6.39	0.0017	0.85
47	-6.14	0.0022	1.00	-6.39	0.0017	0.77	-6.29	0.0017	0.86	-6.51	0.0015	0.69	-6.29	0.0018	0.86
48	-6.05	0.0024	1.00	-6.30	0.0018	0.78	-6.19	0.0018	0.86	-6.41	0.0016	0.69	-6.20	0.0020	0.86
49	-5.95	0.0026	1.00	-6.20	0.0020	0.78	-6.10	0.0020	0.87	-6.32	0.0018	0.70	-6.10	0.0022	0.86
50	-5.86	0.0028	1.00	-6.10	0.0022	0.78	-6.00	0.0022	0.87	-6.22	0.0020	0.70	-6.00	0.0025	0.87
51	-5.77	0.0031	1.00	-6.01	0.0025	0.79	-5.91	0.0025	0.87	-6.12	0.0022	0.70	-5.91	0.0027	0.87
52	-5.68	0.0034	1.00	-5.91	0.0027	0.79	-5.81	0.0027	0.88	-6.03	0.0024	0.71	-5.81	0.0030	0.88
53	-5.59	0.0037	1.00	-5.82	0.0030	0.80	-5.71	0.0030	0.88	-5.93	0.0027	0.71	-5.71	0.0033	0.88
54	-5.49	0.0041	1.00	-5.72	0.0033	0.80	-5.62	0.0033	0.89	-5.83	0.0029	0.71	-5.62	0.0036	0.88
55	-5.40	0.0045	1.00	-5.62	0.0036	0.80	-5.52	0.0036	0.89	-5.74	0.0032	0.71	-5.52	0.0040	0.89
56	-5.31	0.0049	1.00	-5.53	0.0040	0.81	-5.42	0.0040	0.89	-5.64	0.0035	0.72	-5.43	0.0044	0.89
57	-5.22	0.0054	1.00	-5.43	0.0044	0.81	-5.33	0.0044	0.90	-5.55	0.0039	0.72	-5.33	0.0048	0.89
58	-5.13	0.0059	1.00	-5.33	0.0048	0.81	-5.23	0.0048	0.90	-5.45	0.0043	0.72	-5.23	0.0053	0.90
59	-5.03	0.0065	1.00	-5.24	0.0053	0.82	-5.13	0.0053	0.90	-5.35	0.0047	0.73	-5.14	0.0059	0.90
60	-4.94	0.0071	1.00	-5.14	0.0059	0.82	-5.04	0.0059	0.91	-5.26	0.0052	0.73	-5.04	0.0065	0.91
61	-4.85	0.0078	1.00	-5.04	0.0064	0.82	-4.94	0.0064	0.91	-5.16	0.0057	0.73	-4.94	0.0071	0.91
62	-4.76	0.0086	1.00	-4.95	0.0071	0.83	-4.84	0.0071	0.92	-5.06	0.0063	0.74	-4.85	0.0078	0.91
63	-4.67	0.0094	1.00	-4.85	0.0078	0.83	-4.75	0.0078	0.92	-4.97	0.0070	0.74	-4.75	0.0086	0.92
64	-4.57	0.0103	1.00	-4.75	0.0086	0.83	-4.65	0.0086	0.92	-4.87	0.0077	0.74	-4.65	0.0095	0.92
65	-4.48	0.0113	1.00	-4.66	0.0095	0.84	-4.56	0.0095	0.93	-4.77	0.0084	0.75	-4.56	0.0105	0.93
66	-4.39	0.0124	1.00	-4.56	0.0104	0.84	-4.46	0.0104	0.93	-4.68	0.0093	0.75	-4.46	0.0115	0.93
67	-4.30	0.0136	1.00	-4.47	0.0115	0.85	-4.36	0.0115	0.94	-4.58	0.0102	0.75	-4.37	0.0127	0.93
68	-4.21	0.0149	1.00	-4.37	0.0127	0.85	-4.27	0.0127	0.94	-4.48	0.0113	0.76	-4.27	0.0140	0.94
69	-4.11	0.0163	1.00	-4.27	0.0139	0.85	-4.17	0.0139	0.95	-4.39	0.0124	0.76	-4.17	0.0154	0.94
70	-4.02	0.0179	1.00	-4.18	0.0154	0.86	-4.07	0.0154	0.95	-4.29	0.0137	0.76	-4.08	0.0170	0.95
71	-3.93	0.0196	1.00	-4.08	0.0169	0.86	-3.98	0.0169	0.95	-4.20	0.0151	0.77	-3.98	0.0187	0.95
72	-3.84	0.0215	1.00	-3.98	0.0186	0.86	-3.88	0.0186	0.96	-4.10	0.0166	0.77	-3.88	0.0206	0.96
73	-3.75	0.0236	1.00	-3.89	0.0205	0.87	-3.78	0.0205	0.96	-4.00	0.0183	0.77	-3.79	0.0227	0.96
74	-3.65	0.0259	1.00	-3.79	0.0226	0.87	-3.69	0.0226	0.97	-3.91	0.0201	0.78	-3.69	0.0250	0.96
75	-3.56	0.0284	1.00	-3.69	0.0249	0.88	-3.59	0.0249	0.97	-3.81	0.0221	0.78	-3.59	0.0275	0.97
76	-3.47	0.0311	1.00	-3.60	0.0274	0.88	-3.50	0.0274	0.97	-3.71	0.0244	0.78	-3.50	0.0303	0.97
77	-3.38	0.0341	1.00	-3.50	0.0301	0.88	-3.40	0.0301	0.98	-3.62	0.0269	0.79	-3.40	0.0333	0.98
78	-3.29	0.0374	1.00	-3.41	0.0332	0.89	-3.30	0.0332	0.98	-3.52	0.0296	0.79	-3.30	0.0367	0.98
79	-3.19	0.0410	1.00	-3.31	0.0366	0.89	-3.21	0.0366	0.99	-3.42	0.0326	0.79	-3.21	0.0404	0.99
80	-3.10	0.0450	1.00	-3.21	0.0403	0.89	-3.11	0.0403	0.99	-3.33	0.0359	0.80	-3.11	0.0445	0.99

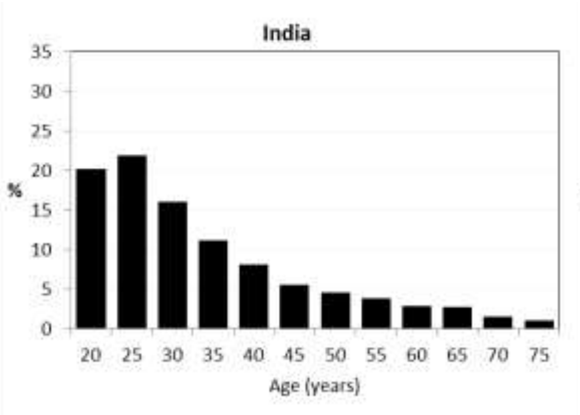
Source: author's calculations based on ONS LS

Table B9. Comparison of hazard ratios for mortality for different specifications of baseline hazard (no entry constraints; 5-year exit if LTFU).[37]

Different hazard specifications	Gompertz					Cox					Piecewise Constant				
	Log Haz	Std Error	Z-score	P-value	Haz Ratio	Log Haz	Std Error	Z-score	P-value	Haz Ratio	Log Haz	Std Error	Z-score	P-value	Haz Ratio
Sex															
Male	**0**				**1**	**0**				**1**	**0**				**1**
Female	-0.49	0.01	-39.74	*0.00*	0.61	-0.49	0.01	-39.83	*0.00*	0.61	-0.50	0.01	-39.77	*0.00*	0.61
Period															
1971-1981	**0**				**1**	**0**				**1**	**0**				**1**
1981-1991	-0.10	0.02	-4.51	*0.00*	0.91	-0.12	0.02	-5.11	*0.00*	0.89	-0.11	0.02	-4.71	*0.00*	0.90
1991-2001	-0.16	0.02	-7.18	*0.00*	0.85	-0.21	0.02	-9.17	*0.00*	0.81	-0.18	0.02	-7.97	*0.00*	0.83
Country of birth															
England and Wales	**0**				**1**	**0**				**1**	**0**				**1**
Scotland	0.24	0.05	6.21	*0.00*	1.27	0.25	0.05	6.50	*0.00*	1.29	0.25	0.05	6.47	*0.00*	1.29
Northern Ireland	0.24	0.09	3.39	*0.00*	1.27	0.24	0.09	3.51	*0.00*	1.28	0.24	0.09	3.52	*0.00*	1.28
Republic of Ireland	0.19	0.05	4.73	*0.00*	1.20	0.19	0.05	4.90	*0.00*	1.21	0.20	0.05	4.96	*0.00*	1.22
India	-0.03	0.04	-0.64	*0.52*	0.97	-0.01	0.04	-0.33	*0.74*	0.99	-0.02	0.04	-0.38	*0.70*	0.98
Pakistan	-0.18	0.06	-2.32	*0.02*	0.84	-0.17	0.06	-2.19	*0.03*	0.85	-0.17	0.06	-2.28	*0.02*	0.84
Bangladesh	-0.21	0.10	-1.73	*0.08*	0.81	-0.20	0.10	-1.72	*0.09*	0.82	-0.21	0.10	-1.76	*0.08*	0.81
Jamaica	0.07	0.07	1.07	*0.29*	1.08	0.08	0.07	1.14	*0.26*	1.08	0.08	0.07	1.17	*0.24*	1.08
Other Caribbean	-0.12	0.08	-1.24	*0.22*	0.89	-0.11	0.09	-1.13	*0.26*	0.90	-0.11	0.09	-1.13	*0.26*	0.90
East and South Africa	-0.13	0.08	-1.34	*0.18*	0.88	-0.12	0.08	-1.23	*0.22*	0.89	-0.13	0.08	-1.33	*0.18*	0.88
West and Central Africa	-0.08	0.13	-0.56	*0.58*	0.92	-0.05	0.13	-0.37	*0.71*	0.95	-0.06	0.13	-0.45	*0.65*	0.94
Western Europe	-0.36	0.05	-5.46	*0.00*	0.70	-0.36	0.05	-5.45	*0.00*	0.70	-0.36	0.05	-5.42	*0.00*	0.70
Eastern Europe	0.03	0.07	0.37	*0.71*	1.03	0.01	0.07	0.19	*0.85*	1.01	0.03	0.07	0.39	*0.70*	1.03
China	-0.20	0.12	-1.34	*0.18*	0.82	-0.19	0.12	-1.31	*0.19*	0.83	-0.20	0.12	-1.34	*0.18*	0.82
Other Asia	-0.34	0.09	-2.81	*0.01*	0.71	-0.33	0.09	-2.72	*0.01*	0.72	-0.34	0.09	-2.78	*0.01*	0.71
Rest of the World	-0.06	0.05	-1.13	*0.26*	0.94	-0.05	0.05	-1.00	*0.32*	0.95	-0.05	0.05	-1.04	*0.30*	0.95
Indeterminable	0.67	0.18	7.37	*0.00*	1.95	0.67	0.18	7.45	*0.00*	1.96	0.67	0.18	7.45	*0.00*	1.96
Age															
20-24											-2.10	0.01	-50.36	*0.00*	0.12
25-29											-2.05	0.01	-50.74	*0.00*	0.13
30-34											-1.80	0.01	-48.75	*0.00*	0.17
35-39											-1.51	0.01	-44.85	*0.00*	0.22
40-44											-0.99	0.01	-34.64	*0.00*	0.37
45-49											-0.49	0.02	-19.37	*0.00*	0.61
50-54											**0**				**1**
55-59											0.53	0.04	23.15	*0.00*	1.70
60-64											1.02	0.06	44.53	*0.00*	2.77
65-69											1.47	0.11	59.87	*0.00*	4.34
70+											1.93	0.20	66.08	*0.00*	6.90

Source: author's calculations based on ONS LS

[37] Gompertz (constant) **0.00000442**; (SE) **0.000000140**; (z-score) **-390.66**; (p-value) **0.00**; Gompertz (gamma) **0.007776**; (SE) **5.08E-05**; (z-score) **151.13**; (p-value) **0.00**; No constant produced for cox specification of baseline hazard; Piecewise constant (constant) **0.000568**; (SE) **0.0000145**; (z-score) **-291.94**; (p-value) **0.00**


India
%
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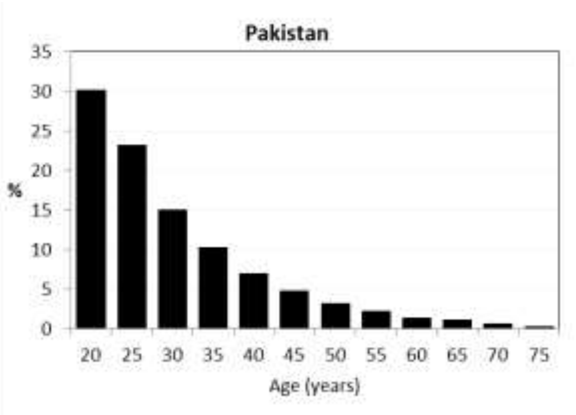
20 25 30 35 40 45 50 55 60 65 70 75
Age (years)


Pakistan
%
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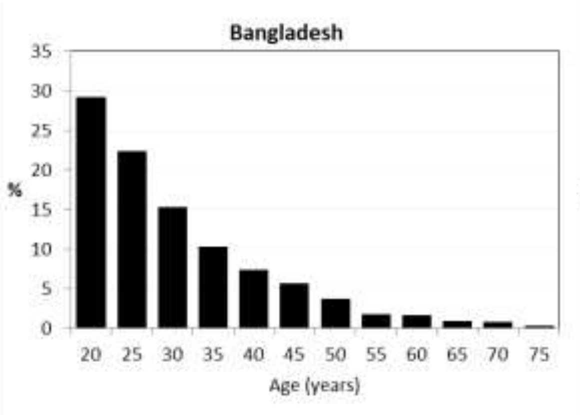
Age (years)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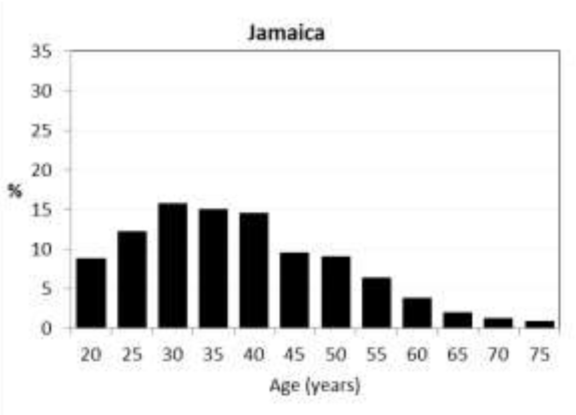
Age (years)


Jamaica
%
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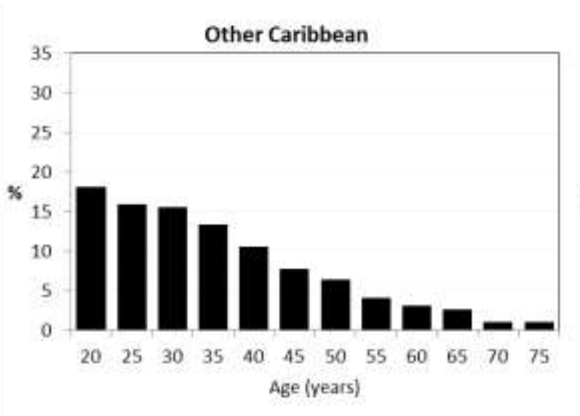
Age (years)


Other Caribbean
%
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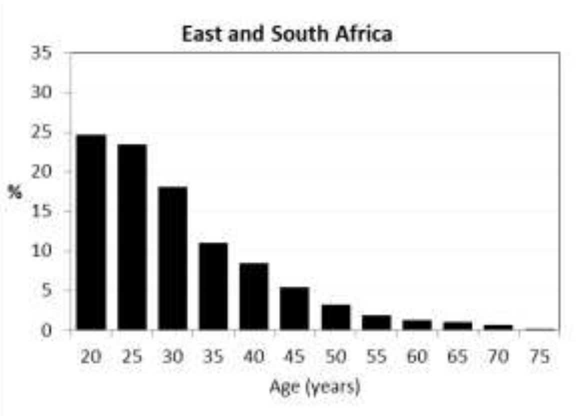
Age (years)


East and South Africa
%
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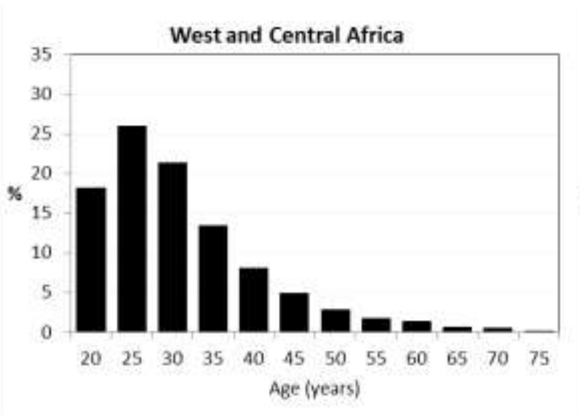
20 25 30 35 40 45 50 55 60 65 70 75
Age (years)


West and Central Africa
%
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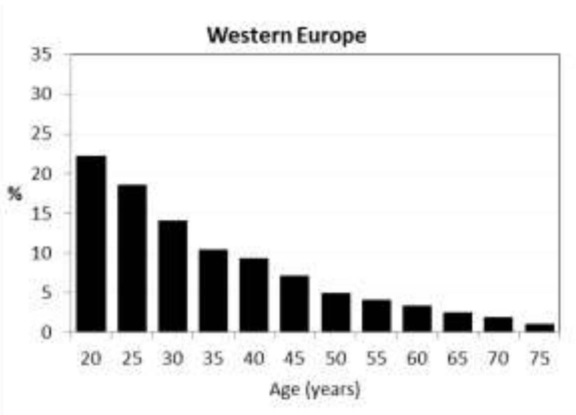
20 25 30 35 40 45 50 55 60 65 70 75
Age (years)


Western Europe
%
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20 25 30 35 40 45 50 55 60 65 70 75
Age (years)

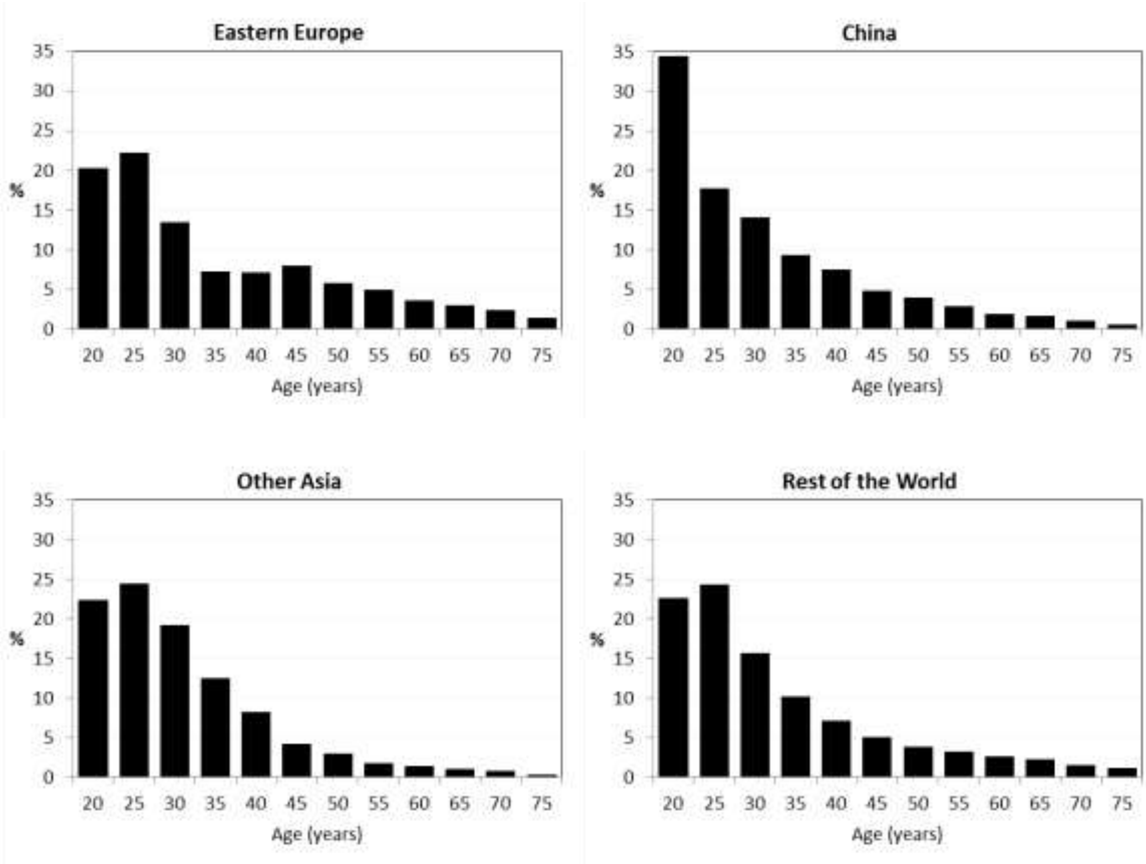

Figure B1. Age at migration by country of birth 1971-2011.
Source: author's calculations based on the ONS LS

Table B10. Age at migration by country of birth 1971-2011.

Age	India		Pakistan		Bangladesh		Jamaica		Other Caribbean		ES Africa		WC Africa	
(years)	Freq	%	Freq	%	Freq	%	Freq	%	Freq	%	Freq	%	Freq	%
20	2 943	20,2	2 096	30,1	904	29,3	293	8,9	440	18,1	1 359	24,7	849	18,3
25	3 191	21,9	1 621	23,3	692	22,4	404	12,3	388	16,0	1 292	23,5	1 206	26,0
30	2 344	16,1	1 047	15,0	475	15,4	520	15,8	380	15,6	997	18,1	996	21,5
35	1 631	11,2	716	10,3	321	10,4	497	15,1	325	13,4	608	11,0	624	13,4
40	1 185	8,1	489	7,0	229	7,4	481	14,6	257	10,6	469	8,5	379	8,2
45	815	5,6	335	4,8	177	5,7	317	9,6	188	7,7	304	5,5	232	5,0
50	666	4,6	231	3,3	116	3,8	302	9,2	158	6,5	181	3,3	134	2,9
55	561	3,9	162	2,3	57	1,8	211	6,4	100	4,1	108	2,0	82	1,8
60	431	3,0	104	1,5	52	1,7	130	3,9	78	3,2	72	1,3	70	1,5
65	397	2,7	80	1,1	29	0,9	67	2,0	64	2,6	63	1,1	33	0,7
70	226	1,6	48	0,7	27	0,9	43	1,3	27	1,1	40	0,7	26	0,6
75	158	1,1	28	0,4	10	0,3	31	0,9	27	1,1	16	0,3	10	0,2
Total	14 548	100	6 957	100	3 089	100	3 296	100	2 432	100	5 509	100	4 641	100

Age	W Europe		E Europe		China		Other Asia		Rest of World	
(years)	Freq	%	Freq	%	Freq	%	Freq	%	Freq	%
20	2 730	22,3	2 778	20,37	998	34,4	1 469	22,4	4 632	22,6
25	2 284	18,6	3 033	22,24	514	17,7	1 600	24,4	4 982	24,3
30	1 729	14,1	1 841	13,50	408	14,1	1 261	19,3	3 216	15,7
35	1 289	10,5	999	7,33	272	9,4	821	12,5	2 106	10,3
40	1 149	9,4	984	7,22	217	7,5	539	8,2	1 476	7,2
45	881	7,2	1 094	8,02	141	4,9	282	4,3	1 045	5,1
50	613	5,0	787	5,77	116	4,0	199	3,0	806	3,9
55	506	4,1	673	4,94	83	2,9	120	1,8	672	3,3
60	416	3,4	503	3,69	55	1,9	98	1,5	544	2,7
65	306	2,5	417	3,06	48	1,7	73	1,1	466	2,3
70	231	1,9	335	2,46	31	1,1	57	0,9	320	1,6
75	135	1,1	191	1,40	17	0,6	27	0,4	251	1,2
Total	12 269	100	13 635	100	2 900	100	6 546	100	20 516	100

Source: author's calculations based on the ONS LS

Appendix C: Chapter II

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Table C1. Model 1a from Chapter II with log relative odds, standard errors, z-score and p-values (sex-adjusted).[38]

Model 1a	**Remigration**					**Mortality**				
	Log Odds	S.E	Z-scores	P-value	Odds Ratio	Log Odds	S.E	Z-scores	P-value	Odds Ratio
Age (years)										
20-24	0.37	0.05	7.52	*0.00*	1.45	-1.39	0.23	-6.03	*0.00*	0.25
25-29	0.11	0.05	2.40	*0.02*	1.12	-1.39	0.19	-7.31	*0.00*	0.25
30-34	0.02	0.04	0.37	*0.71*	1.02	-1.45	0.16	-8.93	*0.00*	0.23
35-39	-0.05	0.05	-1.15	*0.25*	0.95	-0.81	0.12	-6.53	*0.00*	0.44
40-44	-0.07	0.05	-1.45	*0.15*	0.93	-0.37	0.11	-3.34	*0.00*	0.69
45-49	**0**				**1**	**0**				**1**
50-54	-0.03	0.05	-0.60	*0.55*	0.97	0.39	0.10	4.04	*0.00*	1.47
55-59	0.13	0.05	2.45	*0.01*	1.14	0.82	0.09	8.92	*0.00*	2.26
60-64	0.12	0.06	2.17	*0.03*	1.13	1.34	0.09	15.51	*0.00*	3.81
65-69	0.03	0.06	0.54	*0.59*	1.03	1.96	0.08	23.29	*0.00*	7.08
70-74	0.25	0.07	3.68	*0.00*	1.29	2.59	0.09	30.30	*0.00*	13.31
75-79	0.15	0.09	1.82	*0.07*	1.17	3.19	0.09	36.21	*0.00*	24.34
80-84	0.11	0.14	0.81	*0.42*	1.12	3.90	0.10	38.39	*0.00*	49.28
85+	0.86	0.19	4.46	*0.00*	2.36	5.13	0.14	37.15	*0.00*	169.86
Period										
1991-2001	**0**				**1**	**0**				**1**
2001-2011	0.49	0.02	22.88	*0.00*	1.64	-0.46	0.03	-13.38	*0.00*	0.63
Country of birth										
India	**0**				**1**	**0**				**1**
Pakistan	-0.01	0.05	-0.27	*0.78*	0.99	-0.10	0.07	-1.33	*0.18*	0.91
Bangladesh	-0.25	0.06	-4.04	*0.00*	0.78	-0.13	0.11	-1.24	*0.21*	0.88
Jamaica	0.62	0.06	10.47	*0.00*	1.86	0.12	0.07	1.58	*0.11*	1.12
Other Caribbean	0.59	0.06	9.41	*0.00*	1.81	-0.03	0.09	-0.32	*0.75*	0.97
East and South Africa	0.01	0.05	0.30	*0.77*	1.01	0.08	0.08	0.93	*0.35*	1.08
West and Central Africa	0.37	0.06	6.41	*0.00*	1.45	0.45	0.11	3.88	*0.00*	1.56
Western Europe	0.61	0.04	15.69	*0.00*	1.84	0.07	0.05	1.40	*0.16*	1.08
Eastern Europe	0.27	0.06	4.76	*0.00*	1.31	0.22	0.06	3.79	*0.00*	1.25
China	0.58	0.06	9.13	*0.00*	1.79	0.01	0.12	0.05	*0.96*	1.01
Other Asia	0.42	0.05	8.91	*0.00*	1.51	-0.12	0.09	-1.24	*0.21*	0.89
Rest of the World	0.71	0.04	19.85	*0.00*	2.04	0.16	0.06	2.78	*0.01*	1.17
Gender										
Male	**0**				**1**	**0**				**1**
Female	-0.20	0.02	-9.71	*0.00*	0.82	-0.52	0.03	-15.54	*0.00*	0.59
LLTI										
No	**0**				**1**	**0**				**1**
Yes	0.07	0.03	2.17	*0.03*	1.07	1.02	0.03	29.64	*0.00*	2.79
Time since entry										
<5 years	**0**				**1**					
6-10 years	-1.17	0.03	-37.12	*0.00*	0.31			*(Constrained)*		
11-15 years	-1.36	0.04	-30.75	*0.00*	0.26					
16 years +	-1.90	0.03	-70.75	*0.00*	0.15					

Source: author's calculations based on ONS LS

[38] Remigration (constant) **-0.8821237**; (SE) **0.0496857**; (z-score) **-17.75**; (p-value) **0.00**; Death (constant) **-3.21446**; (SE) **0.0829829**; (z-score) **-38.74**; (p-value) **0.00**

Table C2. Model 1b from Chapter II with log relative odds, standard errors, z-score and p-values (sex-adjusted).

Model 1b	Remigration					Mortality				
	Log Odds	S.E	Z-scores	P-value	Odds Ratio	Log Odds	S.E	Z-scores	P-value	Odds Ratio
Age (years)										
20-24	0.06	0.05	1.12	*0.26*	1.06	-1.75	0.24	-7.41	*0.00*	0.17
25-29	-0.08	0.05	-1.60	*0.11*	0.93	-1.54	0.19	-8.03	*0.00*	0.21
30-34	-0.08	0.05	-1.80	*0.07*	0.92	-1.51	0.16	-9.29	*0.00*	0.22
35-39	-0.10	0.05	-2.10	*0.04*	0.91	-0.83	0.12	-6.67	*0.00*	0.43
40-44	-0.09	0.05	-1.82	*0.07*	0.92	-0.38	0.11	-3.44	*0.00*	0.69
45-49	**0**				**1**	**0**				**1**
50-54	-0.03	0.05	-0.54	*0.59*	0.97	0.38	0.10	4.01	*0.00*	1.47
55-59	0.14	0.05	2.62	*0.01*	1.15	0.80	0.09	8.76	*0.00*	2.23
60-64	0.14	0.06	2.55	*0.01*	1.15	1.30	0.09	15.02	*0.00*	3.67
65-69	0.05	0.06	0.80	*0.43*	1.05	1.88	0.08	22.15	*0.00*	6.53
70-74	0.27	0.07	3.77	*0.00*	1.30	2.46	0.09	28.33	*0.00*	11.72
75-79	0.11	0.09	1.28	*0.20*	1.12	2.89	0.09	31.02	*0.00*	18.05
80-84	0.07	0.14	0.47	*0.64*	1.07	3.56	0.11	33.08	*0.00*	35.03
85+	0.80	0.20	4.09	*0.00*	2.23	4.76	0.14	33.21	*0.00*	116.78
Period										
1991-2001	**0**				**1**	**0**				**1**
2001-2011	0.43	0.02	19.27	*0.00*	1.54	-0.40	0.04	-11.30	*0.00*	0.67
Country of birth										
India	**0**				**1**	**0**				**1**
Pakistan	0.03	0.05	0.64	*0.52*	1.03	-0.15	0.07	-2.00	*0.05*	0.86
Bangladesh	-0.22	0.06	-3.55	*0.00*	0.80	-0.20	0.11	-1.90	*0.06*	0.82
Jamaica	0.50	0.06	8.31	*0.00*	1.65	0.02	0.08	0.31	*0.76*	1.02
Other Caribbean	0.45	0.06	7.07	*0.00*	1.57	-0.08	0.09	-0.84	*0.40*	0.93
East and South Africa	-0.08	0.05	-1.69	*0.09*	0.92	0.05	0.08	0.62	*0.53*	1.05
West and Central Africa	0.23	0.06	3.86	*0.00*	1.26	0.43	0.12	3.68	*0.00*	1.54
Western Europe	0.51	0.04	12.67	*0.00*	1.66	0.06	0.05	1.13	*0.26*	1.06
Eastern Europe	0.16	0.06	2.83	*0.01*	1.18	0.18	0.06	3.03	*0.00*	1.20
China	0.51	0.06	7.95	*0.00*	1.67	0.00	0.12	-0.02	*0.98*	1.00
Other Asia	0.30	0.05	6.34	*0.00*	1.35	-0.13	0.09	-1.36	*0.17*	0.88
Rest of the World	0.59	0.04	16.02	*0.00*	1.81	0.14	0.06	2.38	*0.02*	1.15
Gender										
Male	**0**				**1**	**0**				**1**
Female	-0.21	0.02	-9.60	*0.00*	0.81	-0.64	0.04	-17.61	*0.00*	0.53
LLTI										
No	**0**				**1**	**0**				**1**
Yes	0.05	0.03	1.42	*0.16*	1.05	0.95	0.04	27.18	*0.00*	2.60
Time since entry										
<5 years	**0**				**1**					
6-10 years	-1.16	0.03	-36.52	*0.00*	0.31					
11-15 years	-1.35	0.04	-30.34	*0.00*	0.26			*(Constrained)*		
16 years+	-1.88	0.03	-68.45	*0.00*	0.15					

Source: author's calculations based on ONS LS

Table C2 (continued).[39]

Model 1b	**Remigration**					**Mortality**				
	Log Odds	S.E	Z-scores	P-value	Odds Ratio	Log Odds	S.E	Z-scores	P-value	Odds Ratio
Occupation type										
Professional/Managerial	**0**				**1**	**0**				**1**
Skilled	-0.11	0.03	-3.64	*0.00*	0.89	-0.01	0.06	-0.08	*0.93*	0.99
Unskilled	-0.10	0.04	-2.87	*0.00*	0.90	0.08	0.06	1.25	*0.21*	1.08
Missing	0.10	0.03	3.01	*0.00*	1.10	0.34	0.06	5.73	*0.00*	1.40
Education level										
No 18+ qualifications	**0**				**1**	**0**				**1**
Degree level +	0.19	0.03	6.43	*0.00*	1.21	-0.18	0.06	-2.87	*0.00*	0.84
A-levels	0.16	0.04	3.95	*0.00*	1.17	-0.16	0.09	-1.80	*0.07*	0.85
Marital Status										
Single	**0**				**1**	**0**				**1**
Married	-0.49	0.03	-16.62	*0.00*	0.61	-0.45	0.06	-7.15	*0.00*	0.64
Divorced	-0.34	0.05	-7.29	*0.00*	0.71	-0.20	0.08	-2.46	*0.01*	0.82
Widowed	-0.41	0.06	-6.69	*0.00*	0.66	-0.21	0.07	-2.78	*0.01*	0.81
Area of residence type										
Rural	**0**				**1**	**0**				**1**
London	0.07	0.02	2.94	*0.00*	1.07	-0.08	0.04	-2.21	*0.03*	0.92
Other Urban	0.01	0.03	0.46	*0.64*	1.01	-0.03	0.05	-0.67	*0.50*	0.97

Source: author's calculations based on ONS LS

[39] Remigration (constant) **-0.4153004**; (SE) **0.0644595**; (z-score) **-6.44**; (p-value) **0.00**; Death (constant) **-2.774276**; (SE) **0.1140495**; (z-score) **-24.33**; (p-value) **0.00**

Table C3. Model 2a from Chapter II with log relative odds, standard errors, z-score and p-values (sex-adjusted).[40]

Model 2a	Remigration					Mortality				
	Log Odds	S.E	Z-scores	P-value	Odds Ratio	Log Odds	S.E	Z-scores	P-value	Odds Ratio
Age (years)										
20-24	0.38	0.05	7.64	*0.00*	1.46	-1.38	0.23	-5.97	*0.00*	0.25
25-29	0.12	0.05	2.50	*0.01*	1.12	-1.38	0.19	-7.26	*0.00*	0.25
30-34	0.02	0.04	0.48	*0.63*	1.02	-1.45	0.16	-8.89	*0.00*	0.24
35-39	-0.05	0.05	-1.08	*0.28*	0.95	-0.81	0.12	-6.52	*0.00*	0.44
40-44	-0.06	0.05	-1.39	*0.17*	0.94	-0.36	0.11	-3.32	*0.00*	0.69
45-49	**0**				**1**	**0**				**1**
50-54	-0.03	0.05	-0.65	*0.52*	0.97	0.39	0.10	4.04	*0.00*	1.47
55-59	0.12	0.05	2.28	*0.02*	1.13	0.81	0.09	8.88	*0.00*	2.26
60-64	0.11	0.06	2.00	*0.05*	1.12	1.34	0.09	15.45	*0.00*	3.80
65-69	0.03	0.06	0.50	*0.61*	1.03	1.95	0.08	23.21	*0.00*	7.05
70-74	0.26	0.07	3.82	*0.00*	1.30	2.58	0.09	30.21	*0.00*	13.26
75-79	0.18	0.09	2.06	*0.04*	1.19	3.19	0.09	36.17	*0.00*	24.30
80-84	0.14	0.14	1.04	*0.30*	1.16	3.90	0.10	38.37	*0.00*	49.27
85+	0.91	0.19	4.70	*0.00*	2.48	5.13	0.14	37.11	*0.00*	169.53
Period										
1991-2001	**0**				**1**	**0**				**1**
2001-2011	0.49	0.02	22.81	*0.00*	1.64	-0.45	0.03	-13.35	*0.00*	0.63
Country of birth										
LLTI No										
India	**0**				**1**	**0**				**1**
Pakistan	0.00	0.05	0.08	*0.94*	1.00	-0.01	0.10	-0.06	*0.95*	0.99
Bangladesh	-0.30	0.07	-4.32	*0.00*	0.74	-0.25	0.17	-1.45	*0.15*	0.78
Jamaica	0.71	0.07	10.42	*0.00*	2.04	0.12	0.11	1.16	*0.25*	1.13
Other Caribbean	0.69	0.07	9.79	*0.00*	1.99	-0.10	0.13	-0.81	*0.42*	0.90
East and South Africa	0.12	0.05	2.19	*0.03*	1.12	0.08	0.11	0.70	*0.48*	1.08
West and Central Africa	0.43	0.06	6.99	*0.00*	1.54	0.28	0.15	1.88	*0.06*	1.33
Western Europe	0.70	0.04	16.45	*0.00*	2.02	0.05	0.07	0.69	*0.49*	1.05
Eastern Europe	0.36	0.06	5.80	*0.00*	1.44	0.29	0.08	3.61	*0.00*	1.33
China	0.68	0.07	10.08	*0.00*	1.98	-0.16	0.16	-1.00	*0.32*	0.85
Other Asia	0.52	0.05	10.35	*0.00*	1.68	-0.17	0.12	-1.41	*0.16*	0.84
Rest of the World	0.82	0.04	20.85	*0.00*	2.28	0.04	0.08	0.55	*0.58*	1.04
LLTI Yes										
India	0.44	0.07	6.43	*0.00*	1.56	1.01	0.07	13.81	*0.00*	2.75
Pakistan	0.38	0.08	4.53	*0.00*	1.46	0.83	0.10	8.08	*0.00*	2.29
Bangladesh	0.38	0.11	3.31	*0.00*	1.46	0.98	0.14	7.23	*0.00*	2.68
Jamaica	0.74	0.11	6.77	*0.00*	2.10	1.09	0.10	10.43	*0.00*	2.97
Other Caribbean	0.68	0.14	4.96	*0.00*	1.97	1.02	0.13	7.73	*0.00*	2.77
East and South Africa	-0.03	0.12	-0.21	*0.84*	0.98	1.02	0.13	8.10	*0.00*	2.78
West and Central Africa	0.69	0.17	3.99	*0.00*	1.99	1.70	0.19	9.17	*0.00*	5.49
Western Europe	0.62	0.08	7.71	*0.00*	1.86	1.06	0.08	13.30	*0.00*	2.88
Eastern Europe	0.32	0.12	2.61	*0.01*	1.38	1.11	0.08	13.15	*0.00*	3.04
China	0.48	0.20	2.34	*0.02*	1.61	1.16	0.19	6.25	*0.00*	3.18
Other Asia	0.24	0.14	1.64	*0.10*	1.27	0.88	0.15	5.95	*0.00*	2.42
Rest of the World	0.53	0.08	6.85	*0.00*	1.70	1.23	0.08	14.51	*0.00*	3.41
Gender										
Male	**0**				**1**	**0**				**1**
Female	-0.20	0.02	-9.74	*0.00*	0.82	-0.52	0.03	-15.49	*0.00*	0.59
Time since entry										
<5 years	**0**				**1**					
6-10 years	-1.17	0.03	-37.01	*0.00*	0.31			*(Constrained)*		
11-15 years	-1.36	0.04	-30.63	*0.00*	0.26					
16 years +	-1.90	0.03	-70.73	*0.00*	0.15					

Source: author's calculations based on ONS LS

[40] Remigration (constant) **-0.960753**; (SE) **0.051628**; (z-score) **-18.61**; (p-value) **0.00**; Death (constant) **-3.188615**; (SE) **0.0886796**; (z-score) **-35.96**; (p-value) **0.00**

Table C4. Model 2b from Chapter II with log relative odds, standard errors, z-score and p-values (sex-adjusted).

Model 2b	Remigration					Mortality				
	Log Odds	S.E	Z-scores	P-value	Odds Ratio	Log Odds	S.E	Z-scores	P-value	Odds Ratio
Age (years)										
20-24	0.07	0.05	1.28	*0.20*	1.07	-1.73	0.24	-7.33	*0.00*	0.18
25-29	-0.07	0.05	-1.47	*0.14*	0.93	-1.53	0.19	-7.97	*0.00*	0.22
30-34	-0.08	0.05	-1.68	*0.09*	0.93	-1.51	0.16	-9.24	*0.00*	0.22
35-39	-0.09	0.05	-2.02	*0.04*	0.91	-0.83	0.12	-6.66	*0.00*	0.43
40-44	-0.08	0.05	-1.75	*0.08*	0.92	-0.38	0.11	-3.43	*0.00*	0.69
45-49	**0**				**1**	**0**				**1**
50-54	-0.03	0.05	-0.59	*0.56*	0.97	0.39	0.10	4.02	*0.00*	1.47
55-59	0.13	0.05	2.46	*0.01*	1.14	0.80	0.09	8.74	*0.00*	2.23
60-64	0.13	0.06	2.37	*0.02*	1.14	1.30	0.09	14.98	*0.00*	3.67
65-69	0.05	0.06	0.75	*0.45*	1.05	1.87	0.08	22.10	*0.00*	6.51
70-74	0.27	0.07	3.89	*0.00*	1.32	2.46	0.09	28.27	*0.00*	11.69
75-79	0.13	0.09	1.47	*0.14*	1.14	2.89	0.09	31.00	*0.00*	18.03
80-84	0.10	0.14	0.69	*0.49*	1.10	3.56	0.11	33.07	*0.00*	35.02
85+	0.85	0.20	4.32	*0.00*	2.33	4.76	0.14	33.18	*0.00*	116.53
Period										
1991-2001	**0**				**1**	**0**				**1**
2001-2011	0.43	0.02	19.25	*0.00*	1.54	-0.40	0.04	-11.27	*0.00*	0.67
Country of birth										
LLTI No										
India	**0**				**1**	**0**				**1**
Pakistan	0.05	0.05	0.94	*0.35*	1.05	-0.07	0.10	-0.64	*0.52*	0.94
Bangladesh	-0.27	0.07	-3.81	*0.00*	0.76	-0.35	0.17	-1.99	*0.05*	0.71
Jamaica	0.59	0.07	8.50	*0.00*	1.80	0.02	0.11	0.21	*0.83*	1.02
Other Caribbean	0.54	0.07	7.66	*0.00*	1.72	-0.16	0.13	-1.30	*0.19*	0.85
East and South Africa	0.01	0.05	0.23	*0.82*	1.01	0.08	0.11	0.67	*0.50*	1.08
West and Central Africa	0.28	0.06	4.50	*0.00*	1.33	0.28	0.15	1.86	*0.06*	1.33
Western Europe	0.60	0.04	13.53	*0.00*	1.81	0.02	0.07	0.31	*0.76*	1.02
Eastern Europe	0.25	0.06	3.89	*0.00*	1.28	0.23	0.08	2.91	*0.00*	1.26
China	0.61	0.07	8.83	*0.00*	1.83	-0.19	0.16	-1.15	*0.25*	0.83
Other Asia	0.40	0.05	7.89	*0.00*	1.49	-0.19	0.12	-1.51	*0.13*	0.83
Rest of the World	0.70	0.04	17.35	*0.00*	2.02	0.03	0.08	0.37	*0.71*	1.03
LLTI Yes										
India	0.40	0.07	5.75	*0.00*	1.49	0.93	0.07	12.64	*0.00*	2.54
Pakistan	0.35	0.08	4.19	*0.00*	1.42	0.70	0.10	6.80	*0.00*	2.02
Bangladesh	0.33	0.11	2.87	*0.00*	1.39	0.85	0.14	6.18	*0.00*	2.33
Jamaica	0.59	0.11	5.34	*0.00*	1.80	0.92	0.11	8.72	*0.00*	2.52
Other Caribbean	0.51	0.14	3.70	*0.00*	1.67	0.91	0.13	6.86	*0.00*	2.49
East and South Africa	-0.13	0.12	-1.09	*0.28*	0.87	0.89	0.13	7.03	*0.00*	2.44
West and Central Africa	0.54	0.17	3.13	*0.00*	1.72	1.59	0.19	8.45	*0.00*	4.91
Western Europe	0.53	0.08	6.53	*0.00*	1.70	0.99	0.08	12.36	*0.00*	2.69
Eastern Europe	0.22	0.12	1.78	*0.07*	1.25	1.01	0.09	11.80	*0.00*	2.74
China	0.44	0.20	2.15	*0.03*	1.55	1.10	0.19	5.94	*0.00*	3.01
Other Asia	0.10	0.14	0.67	*0.50*	1.10	0.79	0.15	5.32	*0.00*	2.21
Rest of the World	0.38	0.08	4.83	*0.00*	1.46	1.12	0.09	13.08	*0.00*	3.06

Source: author's calculations based on ONS LS

Table C4 (continued).[41]

Model 2b	**Remigration**					**Mortality**				
	Log Odds	S.E	Z-scores	P-value	Odds Ratio	Log Odds	S.E	Z-scores	P-value	Odds Ratio
Gender										
Male	**0**				**1**	**0**				**1**
Female	-0.21	0.02	-9.65	*0.00*	0.81	-0.64	0.04	-17.58	*0.00*	0.53
Time since entry										
<5 years	**0**				**1**					
6-10 years	-1.16	0.03	-36.41	*0.00*	0.31			*(Constrained)*		
11-15 years	-1.35	0.04	-30.23	*0.00*	0.26					
16-20 years	-1.88	0.03	-68.40	*0.00*	0.15					
Occupation type										
Professional/Managerial	**0**				**1**	**0**				**1**
Skilled	-0.11	0.03	-3.54	*0.00*	0.90	-0.01	0.06	-0.13	*0.90*	0.99
Unskilled	-0.10	0.04	-2.77	*0.01*	0.91	0.08	0.06	1.20	*0.23*	1.08
Missing	0.10	0.03	3.17	*0.00*	1.11	0.34	0.06	5.71	*0.00*	1.40
Education level										
No 18+ qualifications	**0**				**1**	**0**				**1**
Degree level +	0.19	0.03	6.34	*0.00*	1.21	-0.18	0.06	-2.84	*0.01*	0.84
A-levels	0.15	0.04	3.80	*0.00*	1.16	-0.16	0.09	-1.76	*0.08*	0.85
Marital Status										
Single	**0**				**1**	**0**				**1**
Married	-0.48	0.03	-16.34	*0.00*	0.62	-0.45	0.06	-7.03	*0.00*	0.64
Divorced	-0.33	0.05	-7.01	*0.00*	0.72	-0.20	0.08	-2.43	*0.02*	0.82
Widowed	-0.42	0.06	-6.79	*0.00*	0.66	-0.20	0.07	-2.67	*0.01*	0.82
Area of residence type										
Rural	**0**				**1**	**0**				**1**
London	0.07	0.02	2.97	*0.00*	1.07	-0.09	0.04	-2.27	*0.02*	0.92
Other Urban	0.02	0.03	0.49	*0.62*	1.02	-0.03	0.05	-0.67	*0.50*	0.97

Source: author's calculations based on ONS LS

[41] Remigration (constant) **-0.4986052**; (SE) **0.0661754**; (z-score) **-7.53**; (p-value) **0.00**; Death (constant) **-2.749667**; (SE) **0.1183559**; (z-score) **-23.23**; (p-value) **0.00**

Table C5. Model 3 (20-64) from Chapter II with log relative odds, standard errors, z-score and p-values (sex-adjusted).

Model 20-64	Remigration					Mortality				
SES	Log Odds	S.E	Z-scores	P-value	Odds Ratio	Log Odds	S.E	Z-scores	P-value	Odds Ratio
Age (years)										
20-24	**0**				**1**	**0**				**1**
25-29	-0.13	0.05	-2.90	*0.00*	0.88	0.22	0.28	0.77	*0.44*	1.24
30-34	-0.13	0.05	-2.80	*0.01*	0.88	0.24	0.27	0.89	*0.38*	1.27
35-39	-0.14	0.05	-2.89	*0.00*	0.87	0.91	0.25	3.66	*0.00*	2.48
40-44	-0.13	0.05	-2.57	*0.01*	0.87	1.36	0.24	5.61	*0.00*	3.89
45-49	-0.05	0.05	-0.86	*0.39*	0.95	1.73	0.24	7.17	*0.00*	5.64
50-54	-0.08	0.06	-1.32	*0.19*	0.93	2.10	0.24	8.81	*0.00*	8.17
55-59	0.09	0.06	1.39	*0.16*	1.09	2.51	0.24	10.53	*0.00*	12.24
60-64	0.09	0.06	1.34	*0.18*	1.09	2.99	0.24	12.65	*0.00*	19.94
Period										
1991-2001	**0**				**1**	**0**				**1**
2001-2011	0.39	0.02	16.51	*0.00*	1.48	-0.44	0.05	-8.23	*0.00*	0.65
Country of birth										
LLTI No										
India	**0**				**1**	**0**				**1**
Pakistan	0.06	0.05	1.15	0.25	1.06	0.03	0.13	0.23	*0.82*	1.03
Bangladesh	-0.28	0.07	-3.85	0.00	0.75	-0.37	0.21	-1.80	*0.07*	0.69
Jamaica	0.58	0.08	7.71	0.00	1.79	0.08	0.15	0.57	*0.57*	1.09
Other Caribbean	0.60	0.07	8.06	0.00	1.82	-0.10	0.17	-0.57	*0.57*	0.91
East and South Africa	0.06	0.06	1.00	0.32	1.06	0.09	0.13	0.67	*0.50*	1.09
West and Central Africa	0.33	0.06	5.07	0.00	1.39	0.17	0.18	0.92	*0.36*	1.19
Western Europe	0.65	0.05	14.02	0.00	1.92	-0.06	0.11	-0.53	*0.60*	0.94
Eastern Europe	0.40	0.07	5.80	0.00	1.50	0.20	0.16	1.22	*0.22*	1.22
China	0.64	0.07	8.99	0.00	1.90	-0.22	0.23	-0.94	*0.35*	0.80
Other Asia	0.46	0.05	8.83	0.00	1.59	-0.17	0.16	-1.03	*0.30*	0.84
Rest of the World	0.78	0.04	18.51	0.00	2.19	-0.09	0.12	-0.82	*0.42*	0.91
LLTI Yes										
India	0.34	0.08	4.03	0.00	1.40	1.09	0.11	10.29	*0.00*	2.97
Pakistan	0.32	0.09	3.51	0.00	1.38	0.87	0.13	6.46	*0.00*	2.38
Bangladesh	0.19	0.13	1.47	0.14	1.21	0.85	0.17	4.89	*0.00*	2.35
Jamaica	0.63	0.13	4.70	0.00	1.88	0.95	0.16	5.92	*0.00*	2.58
Other Caribbean	0.43	0.17	2.56	0.01	1.54	0.94	0.20	4.66	*0.00*	2.56
East and South Africa	-0.17	0.13	-1.25	0.21	0.85	1.11	0.16	7.04	*0.00*	3.04
West and Central Africa	0.62	0.19	3.33	0.00	1.86	1.77	0.23	7.70	*0.00*	5.85
Western Europe	0.55	0.10	5.52	0.00	1.73	1.16	0.13	8.97	*0.00*	3.19
Eastern Europe	0.41	0.19	2.21	0.03	1.51	1.27	0.19	6.79	*0.00*	3.54
China	0.26	0.27	0.98	0.33	1.30	1.54	0.27	5.61	*0.00*	4.65
Other Asia	0.01	0.17	0.05	0.96	1.01	0.96	0.23	4.21	*0.00*	2.62
Rest of the World	0.40	0.09	4.42	0.00	1.48	1.31	0.14	9.52	*0.00*	3.70

Source: author's calculations based on ONS LS

Table C5 (continued)[42]

Model 20-64 SES	**Remigration** Log Odds	S.E	Z-scores	P-value	Odds Ratio	**Mortality** Log Odds	S.E	Z-scores	P-value	Odds Ratio
Gender										
Male	**0**				**1**	**0**				**1**
Female	-0.20	0.02	-9.02	*0.00*	0.81	-0.61	0.05	-11.27	*0.00*	0.55
Time since entry										
<5 years	**0**				**1**					
6-10 years	-1.16	0.03	-35.05	*0.00*	0.31			*(Constrained)*		
11-15 years	-1.36	0.05	-29.76	*0.00*	0.26					
16 years +	-1.85	0.03	-62.93	*0.00*	0.16					
Occupation type										
Professional/Managerial	**0**				**1**	**0**				**1**
Skilled	-0.10	0.03	-3.21	*0.00*	0.90	0.01	0.08	0.16	*0.88*	1.01
Unskilled	-0.09	0.04	-2.45	*0.01*	0.91	0.06	0.09	0.72	*0.47*	1.06
Missing	0.13	0.03	3.81	*0.00*	1.14	0.38	0.08	4.59	*0.00*	1.46
Education level										
No 18+ qualifications	**0**				**1**	**0**				**1**
Degree level +	0.19	0.03	6.36	*0.00*	1.21	-0.15	0.09	-1.71	*0.09*	0.86
A-levels	0.15	0.04	3.70	*0.00*	1.16	-0.19	0.12	-1.58	*0.11*	0.82
Marital Status										
Single	**0**				**1**	**0**				**1**
Married	-0.49	0.03	-16.10	*0.00*	0.61	-0.52	0.09	-5.84	*0.00*	0.60
Divorced	-0.33	0.05	-6.82	*0.00*	0.72	-0.19	0.11	-1.74	*0.08*	0.83
Widowed	-0.38	0.08	-4.70	*0.00*	0.68	-0.27	0.13	-2.05	*0.04*	0.76
Area of residence type										
Rural	**0**				**1**	**0**				**1**
London	0.04	0.02	1.71	*0.09*	1.04	-0.01	0.06	-0.10	*0.92*	0.99
Other Urban	0.01	0.03	0.34	*0.74*	1.01	0.05	0.07	0.77	*0.44*	1.05

Source: author's calculations based on ONS LS

[42] Remigration (constant) **-0.4645496**; (SE) **0.0611101**; (z-score) **-7.60**; (p-value) **0.00**; Death (constant) **-4.521767**; (SE) **0.2451193**; (z-score) **-18.45**; (p-value) **0.00**

Table C6. Model 3 (65+) from Chapter II with log relative odds, standard errors, z-score and p-values (sex-adjusted).

Model 65+	**Remigration**					**Mortality**				
SES	Log Odds	S.E	Z-scores	P-value	Odds Ratio	Log Odds	S.E	Z-scores	P-value	Odds Ratio
Age (years)										
65-69	**0**				**1**	**0**				**1**
70-74	0.26	0.08	3.20	*0.00*	1.29	0.59	0.06	10.01	*0.00*	1.80
75-79	0.19	0.10	1.83	*0.07*	1.21	1.05	0.07	15.22	*0.00*	2.86
80-84	0.17	0.15	1.09	*0.27*	1.18	1.72	0.09	19.70	*0.00*	5.60
85+	0.88	0.21	4.25	*0.00*	2.41	2.93	0.13	22.70	*0.00*	18.78
Period										
1991-2001	**0**				**1**	**0**				**1**
2001-2011	0.70	0.08	8.96	*0.00*	2.02	-0.33	0.05	-6.90	*0.00*	0.72
Country of birth										
LLTI No										
India	**0**				**1**	**0**				**1**
Pakistan	0.21	0.22	0.98	0.33	1.24	-0.25	0.20	-1.26	*0.21*	0.78
Bangladesh	0.87	0.31	2.78	0.01	2.40	0.08	0.36	0.21	*0.83*	1.08
Jamaica	0.44	0.18	2.40	0.02	1.55	-0.06	0.16	-0.39	*0.70*	0.94
Other Caribbean	-0.03	0.23	-0.13	0.90	0.97	-0.33	0.19	-1.74	*0.08*	0.72
East and South Africa	-0.30	0.30	-1.01	0.31	0.74	0.11	0.24	0.47	*0.64*	1.12
West and Central Africa	0.43	0.39	1.12	0.26	1.54	0.74	0.31	2.34	*0.02*	2.09
Western Europe	0.09	0.14	0.66	0.51	1.10	-0.03	0.10	-0.27	*0.78*	0.97
Eastern Europe	-0.52	0.17	-2.97	0.00	0.60	0.10	0.10	0.93	*0.35*	1.10
China	0.26	0.25	1.00	0.32	1.29	-0.20	0.24	-0.84	*0.40*	0.82
Other Asia	-0.49	0.25	-1.96	0.05	0.61	-0.34	0.19	-1.76	*0.08*	0.71
Rest of the World	-0.35	0.16	-2.25	0.02	0.70	-0.06	0.11	-0.59	*0.55*	0.94
LLTI Yes										
India	0.13	0.14	0.90	0.37	1.14	0.76	0.11	7.22	*0.00*	2.15
Pakistan	0.16	0.21	0.77	0.44	1.17	0.47	0.16	2.85	*0.00*	1.60
Bangladesh	0.73	0.28	2.62	0.01	2.07	0.99	0.24	4.11	*0.00*	2.69
Jamaica	0.13	0.21	0.63	0.53	1.14	0.82	0.15	5.61	*0.00*	2.26
Other Caribbean	0.32	0.26	1.24	0.21	1.37	0.85	0.18	4.64	*0.00*	2.33
East and South Africa	-0.22	0.30	-0.73	0.47	0.80	0.55	0.21	2.63	*0.01*	1.73
West and Central Africa	-0.15	0.47	-0.33	0.74	0.86	1.18	0.32	3.70	*0.00*	3.24
Western Europe	0.16	0.16	1.02	0.31	1.18	0.82	0.11	7.61	*0.00*	2.26
Eastern Europe	-0.22	0.19	-1.18	0.24	0.80	0.86	0.11	8.02	*0.00*	2.35
China	0.34	0.34	1.02	0.31	1.41	0.82	0.24	3.37	*0.00*	2.27
Other Asia	0.00	0.28	-0.01	0.99	1.00	0.65	0.20	3.28	*0.00*	1.92
Rest of the World	0.07	0.17	0.40	0.69	1.07	0.95	0.11	8.32	*0.00*	2.58

Source: author's calculations based on ONS LS

Table C6 (continued)[43]

Model 65+ SES	Remigration					Mortality				
	Log Odds	S.E	Z-scores	P-value	Odds Ratio	Log Odds	S.E	Z-scores	P-value	Odds Ratio
Gender										
Male	**0**				**1**	**0**				**1**
Female	-0.20	0.07	-2.74	*0.01*	0.82	-0.65	0.05	-12.83	*0.00*	0.52
Time since entry										
<5 years	**0**				**1**					
6-10 years	-1.02	0.12	-8.77	*0.00*	0.36			*(Constrained)*		
11-15 years	-0.73	0.20	-3.66	*0.00*	0.48					
16 years +	-1.91	0.08	-23.93	*0.00*	0.15					
Occupation type										
Professional/Managerial	**0**				**1**	**0**				**1**
Skilled	-0.07	0.13	-0.57	*0.57*	0.93	-0.06	0.10	-0.58	*0.56*	0.94
Unskilled	-0.07	0.14	-0.51	*0.61*	0.93	0.07	0.10	0.64	*0.52*	1.07
Missing	0.06	0.12	0.47	*0.64*	1.06	0.25	0.09	2.81	*0.01*	1.28
Education level										
No 18+ qualifications	**0**				**1**	**0**				**1**
Degree level +	0.10	0.12	0.79	*0.43*	1.10	-0.21	0.10	-2.18	*0.03*	0.81
A-levels	0.07	0.19	0.39	*0.70*	1.08	-0.10	0.14	-0.73	*0.47*	0.91
Marital Status										
Single	**0**				**1**	**0**				**1**
Married	-0.22	0.14	-1.53	*0.13*	0.80	-0.32	0.09	-3.37	*0.00*	0.73
Divorced	-0.09	0.17	-0.54	*0.59*	0.91	-0.16	0.12	-1.30	*0.20*	0.85
Widowed	-0.23	0.15	-1.49	*0.14*	0.80	-0.08	0.10	-0.77	*0.44*	0.93
Area of residence type										
Rural	**0**				**1**	**0**				**1**
London	0.24	0.08	3.12	*0.00*	1.27	-0.11	0.05	-2.16	*0.03*	0.89
Other Urban	0.06	0.10	0.62	*0.54*	1.06	-0.08	0.06	-1.28	*0.20*	0.92

Source: author's calculations based on ONS LS

[43] Remigration (constant) **-0.574063**; (SE) **0.2200443**; (z-score) **-2.61**; (p-value) **0.00**; Death (constant) **0.8279253**; (SE) **0.1486706**; (z-score) **-5.57**; (p-value) **0.00**

Table C7. Model 2b without variable time since entry constraint for death outcome.

Model 2b (no constraints)	Remigration Log Odds	S.E	Z-scores	P-value	Odds Ratio	Mortality Log Odds	S.E	Z-scores	P-value	Odds Ratio
Age (years)										
20-24	0.09	0.05	1.66	*0.10*	1.09	-1.80	0.24	-7.60	*0.00*	0.16
25-29	-0.05	0.05	-1.04	*0.30*	0.95	-1.61	0.19	-8.34	*0.00*	0.20
30-34	-0.07	0.04	-1.59	*0.11*	0.93	-1.53	0.16	-9.36	*0.00*	0.22
35-39	-0.08	0.05	-1.74	*0.08*	0.92	-0.84	0.13	-6.67	*0.00*	0.43
40-44	-0.08	0.05	-1.81	*0.07*	0.92	-0.38	0.11	-3.42	*0.00*	0.69
45-49	**0**				**1**	**0**				**1**
50-54	-0.03	0.05	-0.53	*0.59*	0.97	0.38	0.10	3.94	*0.00*	1.46
55-59	0.16	0.05	3.01	*0.00*	1.17	0.80	0.09	8.64	*0.00*	2.22
60-64	0.17	0.06	2.95	*0.00*	1.18	1.29	0.09	14.80	*0.00*	3.63
65-69	0.08	0.06	1.24	*0.22*	1.08	1.86	0.09	21.82	*0.00*	6.42
70-74	0.30	0.07	4.27	*0.00*	1.35	2.44	0.09	27.93	*0.00*	11.52
75-79	0.18	0.09	2.03	*0.04*	1.20	2.88	0.09	30.64	*0.00*	17.83
80-84	0.15	0.14	1.06	*0.29*	1.16	3.54	0.11	32.73	*0.00*	34.60
85+	0.90	0.20	4.58	*0.00*	2.46	4.74	0.14	32.93	*0.00*	114.27
Period										
1991-2001	**0**				**1**	**0**				**1**
2001-2011	0.44	0.03	17.38	*0.00*	1.55	-0.41	0.05	-7.87	*0.00*	0.66
Country of birth										
LLTI No										
India	**0**				**1**	**0**				**1**
Pakistan	0.05	0.05	0.99	*0.32*	1.05	-0.06	0.10	-0.60	*0.55*	0.94
Bangladesh	-0.26	0.07	-3.70	*0.00*	0.77	-0.35	0.18	-1.98	*0.05*	0.71
Jamaica	0.61	0.07	8.89	*0.00*	1.84	0.03	0.11	0.24	*0.81*	1.03
Other Caribbean	0.57	0.07	8.08	*0.00*	1.77	-0.16	0.13	-1.28	*0.20*	0.85
East and South Africa	0.04	0.05	0.76	*0.45*	1.04	0.08	0.11	0.67	*0.50*	1.08
West and Central Africa	0.29	0.06	4.66	*0.00*	1.34	0.27	0.15	1.77	*0.08*	1.31
Western Europe	0.62	0.04	14.27	*0.00*	1.87	0.03	0.07	0.36	*0.72*	1.03
Eastern Europe	0.25	0.06	3.96	*0.00*	1.29	0.23	0.08	2.91	*0.00*	1.26
China	0.63	0.07	9.17	*0.00*	1.87	-0.19	0.16	-1.15	*0.25*	0.83
Other Asia	0.42	0.05	8.23	*0.00*	1.51	-0.19	0.12	-1.51	*0.13*	0.83
Rest of the World	0.71	0.04	17.58	*0.00*	2.03	0.02	0.08	0.30	*0.76*	1.02
LLTI Yes										
India	0.43	0.07	6.29	*0.00*	1.54	0.94	0.07	12.67	*0.00*	2.55
Pakistan	0.38	0.08	4.61	*0.00*	1.47	0.71	0.10	6.83	*0.00*	2.03
Bangladesh	0.45	0.11	4.10	*0.00*	1.57	0.88	0.14	6.40	*0.00*	2.42
Jamaica	0.62	0.11	5.69	*0.00*	1.86	0.93	0.11	8.75	*0.00*	2.53
Other Caribbean	0.53	0.14	3.87	*0.00*	1.70	0.91	0.13	6.85	*0.00*	2.48
East and South Africa	-0.09	0.12	-0.77	*0.44*	0.91	0.90	0.13	7.06	*0.00*	2.45
West and Central Africa	0.54	0.17	3.12	*0.00*	1.72	1.58	0.19	8.39	*0.00*	4.86
Western Europe	0.55	0.08	6.76	*0.00*	1.73	0.99	0.08	12.36	*0.00*	2.70
Eastern Europe	0.25	0.12	2.07	*0.04*	1.29	1.01	0.09	11.83	*0.00*	2.76
China	0.47	0.20	2.30	*0.02*	1.59	1.11	0.19	5.97	*0.00*	3.03
Other Asia	0.08	0.14	0.57	*0.57*	1.09	0.80	0.15	5.35	*0.00*	2.22
Rest of the World	0.40	0.08	5.22	*0.00*	1.50	1.12	0.09	13.05	*0.00*	3.05

Source: author's calculations based on ONS LS

Table C7 (continued)[44]

Model 2b (no constraints)	**Remigration**					**Mortality**				
	Log Odds	S.E	Z-scores	P-value	Odds Ratio	Log Odds	S.E	Z-scores	P-value	Odds Ratio
Gender										
Male	**0**				**1**	**0**				**1**
Female	-0.23	0.02	-10.55	*0.00*	0.80	-0.64	0.04	-17.58	*0.00*	0.53
Time since entry										
<5 years	**0**				**1**	**0**				**1**
6-10 years	-1.18	0.03	-36.91	*0.00*	0.31	-0.34	0.07	-4.53	*0.00*	0.71
11-15 years	-1.36	0.04	-30.59	*0.00*	0.26	-0.42	0.11	-3.90	*0.00*	0.66
16-20 years	-1.84	0.03	-55.85	*0.00*	0.16	-0.24	0.06	-3.92	*0.00*	0.79
21-25 years	-1.73	0.06	-28.92	*0.00*	0.18	-0.34	0.12	-2.90	*0.00*	0.71
26-30 years	-1.97	0.04	-52.51	*0.00*	0.14	-0.22	0.07	-3.37	*0.00*	0.80
Occupation type										
Professional/Managerial	**0**				**1**	**0**				**1**
Skilled	-0.10	0.03	-3.22	*0.00*	0.91	-0.01	0.06	-0.09	*0.93*	0.99
Unskilled	-0.11	0.04	-3.03	*0.00*	0.90	0.07	0.06	1.13	*0.26*	1.08
Missing	0.09	0.03	2.79	*0.01*	1.10	0.33	0.06	5.58	*0.00*	1.39
Education level										
No 18+ qualifications	**0**				**1**	**0**				**1**
Degree level +	0.19	0.03	6.49	*0.00*	1.21	-0.17	0.06	-2.72	*0.01*	0.84
A-levels	0.16	0.04	4.12	*0.00*	1.18	-0.15	0.09	-1.68	*0.09*	0.86
Marital Status										
Single	**0**				**1**	**0**				**1**
Married	-0.48	0.03	-16.18	*0.00*	0.62	-0.45	0.06	-7.06	*0.00*	0.64
Divorced	-0.31	0.05	-6.71	*0.00*	0.73	-0.20	0.08	-2.41	*0.02*	0.82
Widowed	-0.40	0.06	-6.57	*0.00*	0.67	-0.20	0.07	-2.70	*0.01*	0.82
Area of residence type										
Rural	**0**				**1**	**0**				**1**
London	0.05	0.02	2.28	*0.02*	1.06	-0.09	0.04	-2.36	*0.02*	0.91
Other Urban	-0.01	0.03	-0.16	*0.87*	0.99	-0.04	0.05	-0.77	*0.44*	0.97

Source: author's calculations based on ONS LS

[44] Remigration (constant) **-0.4733204**; (SE) **0.0660282**; (z-score) **-7.17**; (p-value) **0.00**; Death (constant) **2.495211**; (SE) **0.1298022**; (z-score) **-19.22**; (p-value) **0.00**

Table C8. Model 2b with corrected standard errors (to allow for clustering (VCE cluster option)).

Model 2b (VCE cluster)	**Remigration**					**Mortality**				
	Log Odds	S.E	Z-scores	P-value	Odds Ratio	Log Odds	S.E	Z-scores	P-value	Odds Ratio
Age (years)										
20-24	0.07	0.05	1.29	*0.20*	1.07	-1.73	0.24	-7.29	*0.00*	0.18
25-29	-0.07	0.05	-1.46	*0.14*	0.93	-1.53	0.19	-7.95	*0.00*	0.22
30-34	-0.08	0.05	-1.67	*0.09*	0.93	-1.51	0.16	-9.22	*0.00*	0.22
35-39	-0.09	0.05	-2.01	*0.04*	0.91	-0.83	0.13	-6.66	*0.00*	0.43
40-44	-0.08	0.05	-1.74	*0.08*	0.92	-0.38	0.11	-3.43	*0.00*	0.69
45-49	**0**				**1**	**0**				**1**
50-54	-0.03	0.05	-0.59	*0.56*	0.97	0.39	0.10	4.03	*0.00*	1.47
55-59	0.13	0.05	2.45	*0.01*	1.14	0.80	0.09	8.78	*0.00*	2.23
60-64	0.13	0.06	2.37	*0.02*	1.14	1.30	0.09	14.96	*0.00*	3.67
65-69	0.05	0.06	0.75	*0.46*	1.05	1.87	0.09	21.99	*0.00*	6.51
70-74	0.27	0.07	3.91	*0.00*	1.32	2.46	0.09	28.12	*0.00*	11.69
75-79	0.13	0.09	1.45	*0.15*	1.14	2.89	0.09	30.79	*0.00*	18.03
80-84	0.10	0.14	0.68	*0.49*	1.10	3.56	0.11	32.86	*0.00*	35.02
85+	0.85	0.20	4.34	*0.00*	2.33	4.76	0.14	32.84	*0.00*	116.53
Period										
1991-2001	**0**				**1**	**0**				**1**
2001-2011	0.43	0.02	19.36	*0.00*	1.54	-0.40	0.04	-11.20	*0.00*	0.67
Country of birth										
LLTI No										
India	**0**				**1**	**0**				**1**
Pakistan	0.05	0.05	0.92	*0.36*	1.05	-0.07	0.11	-0.62	*0.53*	0.94
Bangladesh	-0.27	0.07	-3.71	*0.00*	0.76	-0.35	0.17	-2.02	*0.04*	0.71
Jamaica	0.59	0.07	8.42	*0.00*	1.80	0.02	0.11	0.21	*0.84*	1.02
Other Caribbean	0.54	0.07	7.56	*0.00*	1.72	-0.16	0.13	-1.26	*0.21*	0.85
East and South Africa	0.01	0.05	0.23	*0.82*	1.01	0.08	0.11	0.68	*0.50*	1.08
West and Central Africa	0.28	0.06	4.39	*0.00*	1.33	0.28	0.15	1.90	*0.06*	1.33
Western Europe	0.60	0.04	13.44	*0.00*	1.81	0.02	0.07	0.31	*0.76*	1.02
Eastern Europe	0.25	0.06	3.99	*0.00*	1.28	0.23	0.08	2.95	*0.00*	1.26
China	0.61	0.07	8.95	*0.00*	1.83	-0.19	0.16	-1.19	*0.23*	0.83
Other Asia	0.40	0.05	7.92	*0.00*	1.49	-0.19	0.12	-1.55	*0.12*	0.83
Rest of the World	0.70	0.04	17.34	*0.00*	2.02	0.03	0.08	0.37	*0.71*	1.03
LLTI Yes										
India	0.40	0.07	5.82	*0.00*	1.49	0.93	0.07	12.61	*0.00*	2.54
Pakistan	0.35	0.08	4.17	*0.00*	1.42	0.70	0.11	6.61	*0.00*	2.02
Bangladesh	0.33	0.12	2.81	*0.01*	1.39	0.85	0.13	6.31	*0.00*	2.33
Jamaica	0.59	0.11	5.14	*0.00*	1.80	0.92	0.11	8.55	*0.00*	2.52
Other Caribbean	0.51	0.14	3.59	*0.00*	1.67	0.91	0.14	6.69	*0.00*	2.49
East and South Africa	-0.13	0.13	-1.03	*0.30*	0.87	0.89	0.13	6.79	*0.00*	2.44
West and Central Africa	0.54	0.18	2.96	*0.00*	1.72	1.59	0.20	8.11	*0.00*	4.91
Western Europe	0.53	0.08	6.41	*0.00*	1.70	0.99	0.08	12.34	*0.00*	2.69
Eastern Europe	0.22	0.12	1.79	*0.07*	1.25	1.01	0.08	11.89	*0.00*	2.74
China	0.44	0.21	2.10	*0.04*	1.55	1.10	0.20	5.60	*0.00*	3.01
Other Asia	0.10	0.14	0.68	*0.50*	1.10	0.79	0.16	5.05	*0.00*	2.21
Rest of the World	0.38	0.08	4.79	*0.00*	1.46	1.12	0.09	13.15	*0.00*	3.06

Source: author's calculations based on ONS LS

Table C8 (continued)[45]

Model 2b (VCE cluster)	Remigration					Mortality				
	Log Odds	S.E	Z-scores	P-value	Odds Ratio	Log Odds	S.E	Z-scores	P-value	Odds Ratio
Gender										
Male	**0**				**1**	**0**				**1**
Female	-0.21	0.02	-9.60	*0.00*	0.81	-0.64	0.04	-17.47	*0.00*	0.53
Time since entry										
<5 years	**0**				**1**					
6-10 years	-1.16	0.03	-36.44	*0.00*	0.31			*(Constrained)*		
11-15 years	-1.35	0.04	-30.19	*0.00*	0.26					
16-20 years	-1.88	0.03	-66.69	*0.00*	0.15					
Occupation type										
Professional/Managerial	**0**				**1**	**0**				**1**
Skilled	-0.11	0.03	-3.51	*0.00*	0.90	-0.01	0.06	-0.13	*0.90*	0.99
Unskilled	-0.10	0.04	-2.74	*0.01*	0.91	0.08	0.06	1.20	*0.23*	1.08
Missing	0.10	0.03	3.13	*0.00*	1.11	0.34	0.06	5.71	*0.00*	1.40
Education level										
No 18+ qualifications	**0**				**1**	**0**				**1**
Degree level +	0.19	0.03	6.32	*0.00*	1.21	-0.18	0.06	-2.83	*0.01*	0.84
A-levels	0.15	0.04	3.83	*0.00*	1.16	-0.16	0.09	-1.76	*0.08*	0.85
Marital Status										
Single	**0**				**1**	**0**				**1**
Married	-0.48	0.03	-16.40	*0.00*	0.62	-0.45	0.07	-6.86	*0.00*	0.64
Divorced	-0.33	0.05	-6.96	*0.00*	0.72	-0.20	0.08	-2.38	*0.02*	0.82
Widowed	-0.42	0.06	-6.79	*0.00*	0.66	-0.20	0.08	-2.63	*0.01*	0.82
Area of residence type										
Rural	**0**				**1**	**0**				**1**
London	0.07	0.02	2.95	*0.00*	1.07	-0.09	0.04	-2.27	*0.02*	0.92
Other Urban	0.02	0.03	0.50	*0.62*	1.02	-0.03	0.05	-0.67	*0.50*	0.97

Source: author's calculations based on ONS LS

[45] Remigration (constant) **-0.4986052**; (SE) **0.067135**; (z-score) **-7.43**; (p-value) **0.00**; Death (constant) **-2.75**; (SE) **0.1178584**; (z-score) **-23.33**; (p-value) **0.00**

Table C9. General health, instead of LLTI, as health variable (interacted with country of birth), 2001-2011.

General Health	Remigration					Mortality				
	Log Odds	S.E	Z-scores	P-value	Odds Ratio	Log Odds	S.E	Z-scores	P-value	Odds Ratio
Age (years)										
20-24	0.14	0.07	2.03	*0.04*	1.15	-2.29	0.47	-4.93	*0.00*	0.10
25-29	-0.09	0.06	-1.47	*0.14*	0.91	-1.60	0.31	-5.17	*0.00*	0.20
30-34	-0.08	0.06	-1.44	*0.15*	0.92	-1.55	0.24	-6.42	*0.00*	0.21
35-39	-0.15	0.06	-2.59	*0.01*	0.86	-1.12	0.20	-5.69	*0.00*	0.33
40-44	-0.12	0.06	-2.06	*0.04*	0.89	-0.31	0.15	-2.11	*0.04*	0.73
45-49	**0**				**1**	**0**				**1**
50-54	-0.01	0.06	-0.10	*0.92*	0.99	0.36	0.13	2.73	*0.00*	1.43
55-59	0.12	0.07	1.77	*0.08*	1.13	0.72	0.13	5.52	*0.00*	2.06
60-64	0.18	0.07	2.58	*0.01*	1.20	1.31	0.12	10.94	*0.00*	3.69
65-69	0.20	0.08	2.60	*0.01*	1.22	2.00	0.11	17.55	*0.00*	7.41
70-74	0.41	0.08	4.94	*0.00*	1.50	2.56	0.11	22.28	*0.00*	12.92
75-79	0.10	0.11	0.97	*0.33*	1.11	3.01	0.12	24.08	*0.00*	20.19
80-84	0.07	0.16	0.40	*0.69*	1.07	3.58	0.14	25.07	*0.00*	35.88
85+	0.72	0.23	3.11	*0.00*	2.05	4.96	0.18	27.54	*0.00*	142.22
Country of birth										
LLTI No										
India	**0**				**1**	**0**				**1**
Pakistan	-0.01	0.06	-0.20	*0.84*	0.99	-0.02	0.12	-0.14	*0.89*	0.98
Bangladesh	-0.17	0.09	-1.97	*0.05*	0.84	0.06	0.18	0.31	*0.75*	1.06
Jamaica	0.52	0.09	5.80	*0.00*	1.69	-0.05	0.13	-0.34	*0.73*	0.96
Other Caribbean	0.39	0.10	4.10	*0.00*	1.48	-0.32	0.16	-1.93	*0.05*	0.73
East and South Africa	-0.10	0.07	-1.56	*0.12*	0.90	0.06	0.13	0.45	*0.65*	1.06
West and Central Africa	0.19	0.08	2.35	*0.02*	1.21	0.46	0.17	2.74	*0.01*	1.58
Western Europe	0.52	0.06	9.37	*0.00*	1.68	0.02	0.09	0.19	*0.85*	1.02
Eastern Europe	0.26	0.08	3.38	*0.00*	1.29	0.23	0.10	2.23	*0.03*	1.26
China	0.51	0.09	5.88	*0.00*	1.67	-0.05	0.19	-0.27	*0.79*	0.95
Other Asia	0.27	0.06	4.25	*0.00*	1.31	-0.12	0.14	-0.83	*0.41*	0.89
Rest of the World	0.63	0.05	12.52	*0.00*	1.88	0.12	0.09	1.25	*0.21*	1.12
LLTI Yes										
India	0.34	0.10	3.33	*0.00*	1.41	0.98	0.10	9.32	*0.00*	2.66
Pakistan	0.28	0.11	2.45	*0.01*	1.32	0.53	0.15	3.55	*0.00*	1.69
Bangladesh	0.48	0.16	3.06	*0.00*	1.62	0.66	0.21	3.10	*0.00*	1.93
Jamaica	0.47	0.17	2.78	*0.01*	1.59	0.79	0.16	4.89	*0.00*	2.19
Other Caribbean	0.33	0.22	1.52	*0.13*	1.40	0.87	0.21	4.15	*0.00*	2.39
East and South Africa	-0.09	0.17	-0.55	*0.58*	0.91	0.92	0.19	4.85	*0.00*	2.51
West and Central Africa	0.44	0.29	1.54	*0.12*	1.56	1.75	0.31	5.71	*0.00*	5.77
Western Europe	0.61	0.12	5.01	*0.00*	1.83	1.19	0.12	9.90	*0.00*	3.28
Eastern Europe	0.02	0.21	0.09	*0.93*	1.02	1.11	0.14	7.82	*0.00*	3.02
China	0.56	0.30	1.89	*0.06*	1.76	1.09	0.31	3.58	*0.00*	2.99
Other Asia	0.08	0.22	0.35	*0.73*	1.08	0.82	0.26	3.13	*0.00*	2.27
Rest of the World	0.75	0.10	7.76	*0.00*	2.11	1.37	0.13	10.32	*0.00*	3.95
Gender										
Male	**0**				**1**	**0**				**1**
Female	-0.19	0.03	-6.99	*0.00*	0.83	-0.61	0.05	-12.28	*0.00*	0.54

Source: author's calculations based on ONS LS

Table C9 (continued)[46]

General Health	Remigration					Mortality				
	Log Odds	S.E	Z-scores	P-value	Odds Ratio	Log Odds	S.E	Z-scores	P-value	Odds Ratio
Time since entry										
<5 years	**0**				**1**					
6-10 years	-1.04	0.04	-25.75	*0.00*	0.35	*(Constrained)*				
11-15 years	-1.23	0.06	-19.12	*0.00*	0.29					
16-20 years	-1.81	0.04	-49.39	*0.00*	0.16					
Occupation type										
Professional/Managerial	**0**				**1**	**0**				**1**
Skilled	-0.09	0.04	-2.40	*0.02*	0.91	0.02	0.08	0.30	*0.77*	1.02
Unskilled	-0.09	0.05	-1.88	*0.06*	0.92	0.24	0.09	2.69	*0.01*	1.27
Missing	0.10	0.04	2.43	*0.02*	1.11	0.37	0.08	4.45	*0.00*	1.45
Education level										
No 18+ qualifications	**0**				**1**	**0**				**1**
Degree level +	0.16	0.03	4.71	*0.00*	1.18	-0.12	0.08	-1.63	*0.10*	0.88
A-levels	0.14	0.05	2.91	*0.00*	1.15	-0.02	0.12	-0.19	*0.85*	0.98
Marital Status										
Single	**0**				**1**	**0**				**1**
Married	-0.52	0.04	-13.65	*0.00*	0.60	-0.54	0.09	-5.79	*0.00*	0.59
Divorced	-0.34	0.06	-6.20	*0.00*	0.71	-0.26	0.11	-2.36	*0.02*	0.77
Widowed	-0.39	0.08	-5.12	*0.00*	0.68	-0.15	0.11	-1.39	*0.16*	0.86
Area of residence type										
Rural	**0**				**1**	**0**				**1**
London	0.02	0.03	0.56	*0.57*	1.02	-0.12	0.05	-2.20	*0.03*	0.89
Other Urban	0.00	0.04	-0.11	*0.91*	1.00	-0.04	0.06	-0.69	*0.49*	0.96

Source: author's calculations based on ONS LS

[46] Remigration (constant) **-8.761221**; (SE) **1.003276**; (z-score) **-8.73**; (p-value) **0.00**; Death (constant) **-9.339716**; (SE) **0.5254978**; (z-score) **-17.77**; (p-value) **0.00**

Table C10. Model 2b, excluding those 'lost to follow-up'. Exits are recorded exits only.

Recorded exits only	Remigration					Mortality				
	Log Odds	S.E	Z-scores	P-value	Odds Ratio	Log Odds	S.E	Z-scores	P-value	Odds Ratio
Age (years)										
20-24	0.67	0.18	3.70	*0.00*	1.96	-1.65	0.24	-6.98	*0.00*	0.19
25-29	0.32	0.17	1.86	*0.06*	1.37	-1.49	0.19	-7.75	*0.00*	0.23
30-34	0.56	0.16	3.45	*0.00*	1.74	-1.49	0.16	-9.12	*0.00*	0.22
35-39	0.45	0.16	2.71	*0.01*	1.56	-0.82	0.13	-6.59	*0.00*	0.44
40-44	0.23	0.18	1.29	*0.20*	1.25	-0.38	0.11	-3.41	*0.00*	0.69
45-49	**0**				**1**	**0**				**1**
50-54	0.13	0.21	0.64	*0.52*	1.14	0.38	0.10	4.02	*0.00*	1.47
55-59	0.74	0.19	3.82	*0.00*	2.10	0.79	0.09	8.66	*0.00*	2.21
60-64	0.92	0.20	4.68	*0.00*	2.52	1.30	0.09	14.90	*0.00*	3.67
65-69	0.79	0.22	3.63	*0.00*	2.20	1.87	0.09	21.84	*0.00*	6.49
70-74	0.98	0.24	4.09	*0.00*	2.67	2.45	0.09	27.83	*0.00*	11.56
75-79	0.69	0.34	2.03	*0.04*	1.99	2.90	0.09	30.58	*0.00*	18.11
80-84	0.92	0.49	1.88	*0.06*	2.51	3.55	0.11	32.60	*0.00*	34.91
85+	2.19	0.52	4.23	*0.00*	8.93	4.76	0.15	32.55	*0.00*	116.45
Period										
1991-2001	**0**				**1**	**0**				**1**
2001-2011	-0.06	0.07	-0.86	*0.39*	0.94	-0.45	0.04	-12.48	*0.00*	0.64
Country of birth										
LLTI No										
India	**0**				**1**	**0**				**1**
Pakistan	-0.64	0.27	-2.34	*0.02*	0.53	-0.03	0.11	-0.29	*0.77*	0.97
Bangladesh	-1.43	0.52	-2.74	*0.01*	0.24	-0.24	0.17	-1.43	*0.15*	0.78
Jamaica	1.22	0.26	4.74	*0.00*	3.38	0.04	0.11	0.40	*0.69*	1.05
Other Caribbean	0.86	0.28	3.07	*0.00*	2.36	-0.19	0.13	-1.45	*0.15*	0.82
East and South Africa	0.04	0.23	0.17	*0.87*	1.04	0.05	0.11	0.44	*0.66*	1.05
West and Central Africa	-0.99	0.43	-2.29	*0.02*	0.37	0.30	0.15	2.03	*0.04*	1.35
Western Europe	1.62	0.16	10.09	*0.00*	5.04	-0.02	0.07	-0.26	*0.79*	0.98
Eastern Europe	0.63	0.23	2.77	*0.01*	1.87	0.15	0.08	1.84	*0.07*	1.16
China	0.80	0.25	3.22	*0.00*	2.22	-0.23	0.16	-1.41	*0.16*	0.80
Other Asia	1.39	0.17	8.27	*0.00*	4.02	-0.23	0.12	-1.88	*0.06*	0.80
Rest of the World	1.62	0.15	10.66	*0.00*	5.03	-0.06	0.08	-0.80	*0.42*	0.94
LLTI Yes										
India	0.14	0.35	0.40	*0.69*	1.15	0.92	0.08	12.29	*0.00*	2.52
Pakistan	0.10	0.44	0.23	*0.82*	1.11	0.68	0.11	6.30	*0.00*	1.98
Bangladesh	1.03	0.42	2.49	*0.01*	2.81	0.92	0.14	6.75	*0.00*	2.50
Jamaica	1.44	0.36	3.96	*0.00*	4.24	0.88	0.11	7.94	*0.00*	2.40
Other Caribbean	0.96	0.53	1.80	*0.07*	2.62	0.91	0.14	6.48	*0.00*	2.47
East and South Africa	-1.21	1.01	-1.19	*0.23*	0.30	0.86	0.13	6.40	*0.00*	2.36
West and Central Africa	1.00	0.62	1.62	*0.11*	2.72	1.52	0.20	7.50	*0.00*	4.58
Western Europe	1.25	0.28	4.49	*0.00*	3.50	0.95	0.08	11.62	*0.00*	2.58
Eastern Europe	-0.43	0.73	-0.59	*0.56*	0.65	0.98	0.09	11.38	*0.00*	2.66
China	0.02	1.03	0.02	*0.98*	1.02	1.10	0.20	5.41	*0.00*	3.01
Other Asia	0.67	0.51	1.31	*0.19*	1.96	0.84	0.16	5.33	*0.00*	2.31
Rest of the World	1.19	0.26	4.62	*0.00*	3.29	1.09	0.09	12.49	*0.00*	2.96

Source: author's calculations based on ONS LS

Table C10 (continued)[47]

Recorded exits only	Remigration					Mortality				
	Log Odds	S.E	Z-scores	P-value	Odds Ratio	Log Odds	S.E	Z-scores	P-value	Odds Ratio
Gender										
Male	**0**				**1**	**0**				**1**
Female	-0.02	0.07	-0.28	*0.78*	0.98	-0.63	0.04	-16.77	*0.00*	0.53
Time since entry										
<5 years	**0**				**1**	*(Constrained)*				
6-10 years	-1.35	0.10	-13.26	*0.00*	0.26					
11-15 years	-1.59	0.15	-10.28	*0.00*	0.20					
16-20 years	-2.31	0.09	-26.32	*0.00*	0.10					
Occupation type										
Professional/Managerial	**0**				**1**	**0**				**1**
Skilled	-0.22	0.09	-2.39	*0.02*	0.80	-0.02	0.06	-0.34	*0.73*	0.98
Unskilled	-0.30	0.12	-2.58	*0.01*	0.74	0.08	0.07	1.26	*0.21*	1.09
Missing	-0.26	0.10	-2.46	*0.01*	0.77	0.33	0.06	5.38	*0.00*	1.38
Education level										
No 18+ qualifications	**0**				**1**	**0**				**1**
Degree level +	0.74	0.09	8.13	*0.00*	2.09	-0.19	0.06	-3.04	*0.00*	0.82
A-levels	0.43	0.11	3.82	*0.00*	1.54	-0.18	0.09	-2.00	*0.05*	0.83
Marital Status										
Single	**0**				**1**	**0**				**1**
Married	-0.07	0.08	-0.88	*0.38*	0.93	-0.39	0.07	-5.87	*0.00*	0.68
Divorced	-0.37	0.16	-2.27	*0.02*	0.69	-0.13	0.08	-1.59	*0.11*	0.87
Widowed	-0.21	0.22	-0.97	*0.33*	0.81	-0.16	0.08	-2.03	*0.04*	0.86
Area of residence type										
Rural	**0**				**1**	**0**				**1**
London	-0.48	0.07	-6.48	*0.00*	0.62	-0.04	0.04	-0.90	*0.37*	0.97
Other Urban	-0.15	0.10	-1.43	*0.15*	0.86	-0.02	0.05	-0.48	*0.63*	0.98

Source: author's calculations based on ONS LS

[47] Remigration (constant) **-3.834006**; (SE) **0.2407594**; (z-score) **-15.92**; (p-value) **0.00**; Death (constant) **-2.723407**; (SE) **0.1195995**; (z-score) **-22.77**; (p-value) **0.00**

Table C11. Model 2b excluding students (individuals aged 20 to 29 years-old)

Model 2b (no students)	Remigration					Mortality				
	Log Odds	S.E	Z-scores	P-value	Odds Ratio	Log Odds	S.E	Z-scores	P-value	Odds Ratio
Age (years)										
30-34	**0**				**1**	**0**				**1**
35-39	-0.04	0.04	-1.00	*0.32*	0.96	0.67	0.18	3.81	*0.00*	1.96
40-44	-0.03	0.04	-0.82	*0.41*	0.97	1.13	0.17	6.76	*0.00*	3.10
45-49	0.03	0.05	0.76	*0.45*	1.04	1.51	0.16	9.23	*0.00*	4.51
50-54	0.00	0.05	0.09	*0.93*	1.00	1.89	0.16	11.92	*0.00*	6.64
55-59	0.17	0.05	3.18	*0.00*	1.18	2.31	0.16	14.75	*0.00*	10.10
60-64	0.17	0.06	2.99	*0.00*	1.18	2.81	0.15	18.26	*0.00*	16.63
65-69	0.09	0.06	1.45	*0.15*	1.09	3.39	0.15	22.16	*0.00*	29.63
70-74	0.32	0.07	4.63	*0.00*	1.38	3.98	0.15	25.77	*0.00*	53.26
75-79	0.20	0.09	2.22	*0.03*	1.22	4.42	0.16	27.96	*0.00*	82.92
80-84	0.16	0.14	1.15	*0.25*	1.18	5.08	0.17	30.46	*0.00*	161.34
85+	0.90	0.20	4.56	*0.00*	2.46	6.28	0.19	32.74	*0.00*	536.11
Period										
1991-2001	**0**				**1**	**0**				**1**
2001-2011	0.46	0.03	17.90	*0.00*	1.59	-0.40	0.04	-11.15	*0.00*	0.67
Country of birth										
LLTI No										
India	**0**				**1**	**0**				**1**
Pakistan	0.16	0.05	2.80	*0.01*	1.18	-0.07	0.11	-0.69	*0.49*	0.93
Bangladesh	-0.15	0.07	-1.80	*0.07*	0.86	-0.29	0.18	-1.61	*0.11*	0.75
Jamaica	0.55	0.07	7.58	*0.00*	1.73	0.01	0.11	0.06	*0.95*	1.01
Other Caribbean	0.50	0.07	6.51	*0.00*	1.65	-0.17	0.13	-1.34	*0.18*	0.84
East and South Africa	-0.03	0.05	-0.49	*0.63*	0.97	0.07	0.12	0.56	*0.57*	1.07
West and Central Africa	0.23	0.06	3.16	*0.00*	1.25	0.28	0.16	1.81	*0.07*	1.32
Western Europe	0.52	0.04	10.73	*0.00*	1.69	0.01	0.07	0.09	*0.93*	1.01
Eastern Europe	-0.01	0.06	-0.10	*0.92*	0.99	0.20	0.08	2.45	*0.01*	1.22
China	0.42	0.07	5.24	*0.00*	1.52	-0.25	0.17	-1.46	*0.14*	0.78
Other Asia	0.28	0.05	4.88	*0.00*	1.33	-0.22	0.13	-1.75	*0.08*	0.80
Rest of the World	0.57	0.04	12.51	*0.00*	1.77	0.00	0.08	-0.06	*0.95*	1.00
LLTI Yes										
India	0.34	0.07	4.78	*0.00*	1.40	0.92	0.07	12.43	*0.00*	2.51
Pakistan	0.33	0.09	3.81	*0.00*	1.39	0.70	0.10	6.71	*0.00*	2.01
Bangladesh	0.31	0.12	2.65	*0.01*	1.37	0.83	0.14	5.96	*0.00*	2.29
Jamaica	0.54	0.11	4.82	*0.00*	1.71	0.91	0.11	8.53	*0.00*	2.47
Other Caribbean	0.48	0.14	3.47	*0.00*	1.62	0.89	0.13	6.67	*0.00*	2.43
East and South Africa	-0.13	0.13	-1.03	*0.31*	0.88	0.88	0.13	6.92	*0.00*	2.42
West and Central Africa	0.52	0.18	2.90	*0.00*	1.68	1.60	0.19	8.45	*0.00*	4.95
Western Europe	0.47	0.08	5.52	*0.00*	1.60	0.97	0.08	12.11	*0.00*	2.65
Eastern Europe	0.19	0.13	1.47	*0.14*	1.20	0.99	0.09	11.57	*0.00*	2.70
China	0.32	0.22	1.45	*0.15*	1.37	1.08	0.19	5.80	*0.00*	2.94
Other Asia	0.08	0.15	0.50	*0.62*	1.08	0.79	0.15	5.30	*0.00*	2.21
Rest of the World	0.32	0.08	3.88	*0.00*	1.38	1.10	0.09	12.81	*0.00*	3.01

Table C11 (continued)[48]

Model 2b (no students)	Remigration					Mortality				
	Log Odds	S.E	Z-scores	P-value	Odds Ratio	Log Odds	S.E	Z-scores	P-value	Odds Ratio
Gender										
Male	**0**				**1**	**0**				**1**
Female	-0.18	0.02	-7.26	*0.00*	0.83	-0.63	0.04	-17.13	*0.00*	0.53
Time since entry										
<5 years	**0**				**1**					
6-10 years	-1.22	0.04	-33.92	*0.00*	0.29			*(Constrained)*		
11-15 years	-1.41	0.05	-28.96	*0.00*	0.24					
16-20 years	-1.93	0.03	-65.07	*0.00*	0.15					
Occupation type										
Professional/Managerial	**0**				**1**	**0**				**1**
Skilled	-0.14	0.04	-4.04	*0.00*	0.87	-0.02	0.06	-0.27	*0.79*	0.98
Unskilled	-0.14	0.04	-3.53	*0.00*	0.87	0.06	0.07	0.96	*0.34*	1.06
Missing	0.04	0.04	1.09	*0.28*	1.04	0.31	0.06	5.21	*0.00*	1.37
Education level										
No 18+ qualifications	**0**				**1**	**0**				**1**
Degree level +	0.10	0.03	2.86	*0.00*	1.10	-0.18	0.06	-2.91	*0.00*	0.83
A-levels	0.07	0.05	1.52	*0.13*	1.08	-0.15	0.09	-1.65	*0.10*	0.86
Marital Status										
Single	**0**				**1**	**0**				**1**
Married	-0.25	0.04	-6.77	*0.00*	0.78	-0.42	0.06	-6.52	*0.00*	0.66
Divorced	-0.10	0.05	-1.97	*0.05*	0.90	-0.18	0.08	-2.16	*0.03*	0.84
Widowed	-0.22	0.07	-3.40	*0.00*	0.80	-0.18	0.07	-2.40	*0.02*	0.84
Area of residence type										
Rural	**0**				**1**	**0**				**1**
London	0.10	0.03	3.53	*0.00*	1.10	-0.09	0.04	-2.38	*0.02*	0.91
Other Urban	0.00	0.04	0.05	*0.96*	1.00	-0.04	0.05	-0.76	*0.45*	0.97

[48] Remigration (constant) **-0.6209618**; (SE) **0.658362**; (z-score) **-9.43**; (p-value) **0.00**; Death (constant) **-4.255619**; (SE) **0.1698337**; (z-score) **-25.06**; (p-value) **0.00**

Appendix D:
Chapter III

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Table D1. Model 1 from Chapter III with log relative hazard, standard errors, z-score and p-values (males).[49]

Model 1 (all-cause)	**Male**									
	Basic					SES				
	Log Haz	S.E	Z-Score	P-value	Haz Ratio	Log Haz	S.E	Z-Score	P-value	Haz Ratio
Period										
1971-81	**0**				**1**	**0**				**1**
1981-91	-0.07	0.03	-2.55	*0.01*	0.93	-0.09	0.03	-3.08	*0.00*	0.92
1991-01	-0.15	0.02	-5.55	*0.00*	0.86	-0.24	0.02	-9.15	*0.00*	0.78
2000-12	-0.33	0.02	-12.30	*0.00*	0.72	-0.41	0.02	-14.96	*0.00*	0.66
Cause of death										
Cardiovascular	**0**				**1**	**0**				**1**
Respiratory	-1.38	0.00	-70.86	*0.00*	0.25	-1.38	0.00	-70.86	*0.00*	0.25
Cancer	-0.08	0.01	-6.16	*0.00*	0.93	-0.08	0.01	-6.15	*0.00*	0.93
Infectious	-3.63	0.00	-66.71	*0.00*	0.03	-3.63	0.00	-66.71	*0.00*	0.03
Other cause	-0.57	0.01	-39.08	*0.00*	0.57	-0.57	0.01	-39.08	*0.00*	0.57
Country of birth										
England and Wales	**0**				**1**	**0**				**1**
Scotland	0.25	0.04	7.54	*0.00*	1.28	0.25	0.04	7.52	*0.00*	1.28
Northern Ireland	0.30	0.08	5.14	*0.00*	1.35	0.19	0.07	3.31	*0.00*	1.21
Irish Republic	0.25	0.04	7.28	*0.00*	1.29	-0.01	0.03	-0.38	*0.71*	0.99
India	-0.12	0.03	-3.22	*0.00*	0.89	-0.18	0.03	-4.89	*0.00*	0.83
Pakistan	-0.31	0.04	-5.25	*0.00*	0.73	-0.46	0.04	-7.67	*0.00*	0.63
Bangladesh	-0.12	0.08	-1.35	*0.18*	0.89	-0.33	0.06	-3.83	*0.00*	0.72
Jamaica	-0.03	0.06	-0.44	*0.66*	0.97	-0.42	0.04	-6.73	*0.00*	0.66
Other Caribbean	-0.13	0.07	-1.58	*0.11*	0.88	-0.37	0.06	-4.56	*0.00*	0.69
East and South Africa	-0.36	0.06	-4.51	*0.00*	0.70	-0.41	0.05	-5.14	*0.00*	0.67
West and Central Africa	0.00	0.09	0.01	*0.99*	1.00	-0.22	0.08	-2.28	*0.02*	0.81
Western Europe	-0.26	0.04	-4.90	*0.00*	0.77	-0.33	0.04	-6.24	*0.00*	0.72
Eastern Europe	-0.02	0.06	-0.40	*0.69*	0.98	-0.23	0.05	-3.70	*0.00*	0.79
China	-0.13	0.09	-1.26	*0.21*	0.87	-0.16	0.09	-1.52	*0.13*	0.85
Other Asia	-0.56	0.06	-5.25	*0.00*	0.57	-0.58	0.06	-5.46	*0.00*	0.56
Rest of the World	-0.17	0.04	-3.38	*0.00*	0.84	-0.22	0.04	-4.31	*0.00*	0.80
Occupation type										
Professional/Managerial						**0**				**1**
Skilled						0.17	0.02	11.38	*0.00*	1.19
Unskilled						0.35	0.02	20.52	*0.00*	1.42
Missing						0.84	0.04	44.48	*0.00*	2.31
Education Level										
Degree level +						-0.40	0.01	-18.60	*0.00*	0.67
A-levels						-0.22	0.02	-7.83	0.00	0.81
No 18+ qualifications						**0**				**1**
Missing						1.40	0.13	43.56	*0.00*	4.07
Marital Status	*(Not adjusted for socioeconomic characteristics)*									
Married						**0**				**1**
Single						0.55	0.03	36.24	0.00	1.74
Divorced						0.37	0.03	20.40	0.00	1.44
Widowed						0.26	0.03	10.80	0.00	1.29
Missing						*(omitted)*				
Area of residence type										
Rural						**0**				**1**
London						0.08	0.02	4.43	0.00	1.08
Other Urban						0.14	0.01	10.54	0.00	1.15
Missing						*(omitted)*				

Source: author's calculations based on ONS LS

[49] Basic (constant) **0.000001660**; (SE) **0.00000005190**; (z-score) **-426.43**; (p-value) **0.00**; Basic (gamma) **0.0076532**; (SE) **0.0000395**; (z-score) **193.55**; (p-value) **0.00**; SES (constant) **0.000001000**; (SE) **0.00000003520**; (z-score) **-393.50**; (p-value) **0.00**; SES (gamma) **0.0079331**; (SE) **0.0000407**; (z-score) **194.85**; (p-value) **0.00**

Table D2. Model 1 from Chapter III with log relative hazard, standard errors, z-score and p-values (females).[50]

Model 1 (all-cause)	Female									
	Basic					SES				
	Log Haz	S.E	Z-Score	P-value	Haz Ratio	Log Haz	S.E	Z-Score	P-value	Haz Ratio
Period										
1971-81	**0**				**1**	**0**				**1**
1981-91	-0.17	0.03	-4.91	*0.00*	0.84	-0.11	0.03	-3.03	*0.00*	0.90
1991-01	-0.28	0.03	-8.38	*0.00*	0.76	-0.19	0.03	-5.59	*0.00*	0.83
2000-12	-0.42	0.02	-12.15	*0.00*	0.66	-0.19	0.03	-5.48	*0.00*	0.82
Cause of death										
Cardiovascular	**0**				**1**	**0**				**1**
Respiratory	-0.98	0.01	-42.30	*0.00*	0.37	-0.98	0.01	-42.30	*0.00*	0.37
Cancer	0.46	0.02	29.57	*0.00*	1.58	0.46	0.02	29.57	*0.00*	1.58
Infectious	-3.20	0.00	-52.32	*0.00*	0.04	-3.20	0.00	-52.32	*0.00*	0.04
Other cause	-0.34	0.01	-18.00	*0.00*	0.71	-0.34	0.01	-18.00	*0.00*	0.71
Country of birth										
England and Wales	**0**				**1**	**0**				**1**
Scotland	0.31	0.06	7.64	*0.00*	1.36	0.30	0.05	7.28	*0.00*	1.35
Northern Ireland	0.14	0.09	1.83	*0.07*	1.15	0.07	0.08	1.00	*0.32*	1.08
Irish Republic	0.22	0.05	5.50	*0.00*	1.25	0.09	0.04	2.11	*0.04*	1.09
India	-0.10	0.04	-2.01	*0.04*	0.91	-0.30	0.04	-6.02	*0.00*	0.74
Pakistan	-0.07	0.07	-0.92	*0.36*	0.93	-0.47	0.05	-5.98	*0.00*	0.62
Bangladesh	-0.41	0.10	-2.78	*0.01*	0.66	-0.90	0.06	-6.06	*0.00*	0.41
Jamaica	0.16	0.08	2.37	*0.02*	1.18	-0.11	0.06	-1.58	*0.12*	0.90
Other Caribbean	-0.20	0.09	-1.88	*0.06*	0.82	-0.38	0.07	-3.62	*0.00*	0.69
East and South Africa	-0.13	0.08	-1.48	*0.14*	0.88	-0.31	0.06	-3.49	*0.00*	0.74
West and Central Africa	-0.45	0.10	-2.77	*0.01*	0.64	-0.66	0.08	-4.04	*0.00*	0.52
Western Europe	-0.26	0.04	-5.15	*0.00*	0.77	-0.36	0.03	-7.22	*0.00*	0.70
Eastern Europe	-0.20	0.06	-2.51	*0.01*	0.82	-0.31	0.06	-3.90	*0.00*	0.74
China	-0.49	0.11	-2.66	*0.01*	0.61	-0.67	0.10	-3.59	*0.00*	0.51
Other Asia	-0.51	0.07	-4.54	*0.00*	0.60	-0.62	0.06	-5.59	*0.00*	0.54
Rest of the World	-0.20	0.05	-3.41	*0.00*	0.82	-0.27	0.04	-4.60	*0.00*	0.76
Occupation type										
Professional/Managerial						**0**				**1**
Skilled						0.03	0.02	1.28	*0.20*	1.03
Unskilled						0.30	0.03	12.70	*0.00*	1.35
Missing						0.64	0.04	28.60	*0.00*	1.90
Education Level										
Degree level +						-0.37	0.02	-12.81	*0.00*	0.69
A-levels						-0.24	0.03	-6.65	0.00	0.79
No 18+ qualifications						**0**				**1**
Missing						1.63	0.19	42.84	*0.00*	5.11
Marital Status	*(Not adjusted for socioeconomic characteristics)*									
Married						**0**				**1**
Single						0.53	0.04	23.94	0.00	1.69
Divorced						0.30	0.03	14.44	0.00	1.35
Widowed						0.17	0.02	9.46	0.00	1.18
Missing						*(omitted)*				
Area of residence type										
Rural						**0**				**1**
London						0.05	0.02	2.35	0.02	1.05
Other Urban						0.14	0.02	9.34	0.00	1.15
Missing						*(omitted)*				

Source: author's calculations based on ONS LS

[50] Basic (constant) **0.000000623**; (SE) **0.00000002470**; (z-score) **-360.45**; (p-value) **0.00**; Basic (gamma) **0.0081072**; (SE) **0.0000487**; (z-score) **166.35**; (p-value) **0.00**; SES (constant) **0.0000004270**; (SE) **0.00000001940**; (z-score) **-323.21**; (p-value) **0.00**; SES (gamma) **0.0078968**; (SE) **0.0000512**; (z-score) **154.23**; (p-value) **0.00**

Table D3. Model 2a from Chapter III with log relative hazard, standard errors, z-score and p-values (basic model).

Model 2a (cause-specific)	Male					Female				
	Log Haz	S.E	Z-Score	P-value	Haz Ratio	Log Haz	S.E	Z-Score	P-value	Haz Ratio
Period										
1971-1981	**0**				**1**	**0**				**1**
1981-1991	-0.07	0.03	-2.56	*0.01*	0.93	-0.17	0.03	-4.91	*0.00*	0.84
1991-2001	-0.15	0.02	-5.56	*0.00*	0.86	-0.28	0.03	-8.39	*0.00*	0.76
2001-2012	-0.33	0.02	-12.31	*0.00*	0.72	-0.42	0.02	-12.17	*0.00*	0.66
Country of birth by cause										
Cardiovascular diseases										
England and Wales	**0**				**1**	**0**				**1**
Scotland	0.00	0.07	3.66	*0.00*	1.23	0.00	0.11	3.67	*0.00*	1.34
Northern Ireland	0.19	0.13	1.88	*0.06*	1.21	0.25	0.18	1.84	*0.07*	1.29
Irish Republic	0.29	0.08	5.05	*0.00*	1.34	0.28	0.10	3.73	*0.00*	1.33
India	0.26	0.07	5.05	*0.00*	1.30	0.27	0.10	3.41	*0.00*	1.31
Pakistan	0.05	0.09	0.62	*0.54*	1.05	0.36	0.18	2.89	*0.00*	1.43
Bangladesh	0.38	0.16	3.42	*0.00*	1.47	-0.13	0.22	-0.53	*0.60*	0.88
Jamaica	0.12	0.11	1.20	*0.23*	1.12	0.50	0.19	4.47	*0.00*	1.65
Other Caribbean	0.07	0.13	0.53	*0.59*	1.07	-0.03	0.18	-0.14	*0.89*	0.97
East and South Africa	-0.29	0.10	-2.29	*0.02*	0.75	-0.22	0.14	-1.24	*0.22*	0.80
West and Central Africa	0.29	0.18	2.11	*0.04*	1.34	-0.19	0.23	-0.68	*0.50*	0.83
Western Europe	-0.17	0.07	-1.99	*0.05*	0.85	-0.09	0.08	-1.04	*0.30*	0.91
Eastern Europe	0.22	0.11	2.38	*0.02*	1.25	0.17	0.15	1.33	*0.18*	1.19
China	-0.11	0.16	-0.61	*0.54*	0.90	-0.22	0.25	-0.71	*0.48*	0.80
Other Asia	-0.54	0.10	-3.06	*0.00*	0.58	-0.43	0.14	-2.06	*0.04*	0.65
Rest of the World	-0.33	0.07	-3.62	*0.00*	0.72	-0.27	0.09	-2.31	*0.02*	0.76
Respiratory diseases										
England and Wales	-1.35	0.01	-64.29	*0.00*	0.26	-0.96	0.01	-38.11	*0.00*	0.38
Scotland	-1.04	0.04	-10.09	*0.00*	0.35	-0.43	0.07	-3.78	*0.00*	0.65
Northern Ireland	-0.89	0.07	-5.05	*0.00*	0.41	-0.62	0.11	-2.93	*0.00*	0.54
Irish Republic	-0.87	0.04	-8.59	*0.00*	0.42	-0.61	0.06	-5.24	*0.00*	0.54
South Asian	-1.71	0.02	-16.18	*0.00*	0.18	-1.12	0.04	-8.79	*0.00*	0.33
Caribbean	-1.88	0.03	-9.19	*0.00*	0.15	-1.18	0.06	-5.77	*0.00*	0.31
African	-2.16	0.03	-8.08	*0.00*	0.12	-1.38	0.07	-5.15	*0.00*	0.25
European	-2.09	0.02	-11.96	*0.00*	0.12	-1.48	0.03	-9.76	*0.00*	0.23
Chinese	-1.87	0.04	-6.99	*0.00*	0.15	-1.92	0.06	-5.09	*0.00*	0.15
Rest of the World	-1.45	0.04	-9.03	*0.00*	0.23	-1.17	0.06	-6.41	*0.00*	0.31
Cancers										
England and Wales	-0.04	0.01	-3.09	*0.00*	0.96	0.50	0.03	29.82	*0.00*	1.65
Scotland	0.19	0.07	3.30	*0.00*	1.21	0.74	0.13	11.43	*0.00*	2.09
Northern Ireland	0.32	0.13	3.33	*0.00*	1.38	0.47	0.20	3.83	*0.00*	1.61
Irish Republic	0.25	0.08	4.35	*0.00*	1.29	0.68	0.12	10.94	*0.00*	1.98
India	-0.86	0.04	-9.71	*0.00*	0.42	-0.08	0.09	-0.89	*0.38*	0.92
Pakistan	-0.69	0.06	-5.76	*0.00*	0.50	0.06	0.15	0.42	*0.68*	1.06
Bangladesh	-0.67	0.10	-3.52	*0.00*	0.51	-0.34	0.20	-1.23	*0.22*	0.71
Jamaica	-0.04	0.10	-0.34	*0.73*	0.96	0.55	0.19	5.02	*0.00*	1.74
Other Caribbean	-0.23	0.11	-1.60	*0.11*	0.80	0.16	0.20	0.95	*0.34*	1.18
East and South Africa	-0.64	0.08	-4.21	*0.00*	0.53	0.08	0.17	0.49	*0.62*	1.08
West and Central Africa	-0.31	0.14	-1.68	*0.09*	0.73	-0.19	0.23	-0.68	*0.50*	0.83
Western Europe	-0.30	0.07	-3.35	*0.00*	0.74	0.22	0.10	2.86	*0.00*	1.25
Eastern Europe	-0.12	0.10	-1.07	*0.28*	0.89	0.15	0.15	1.19	*0.23*	1.17
China	-0.17	0.15	-0.95	*0.34*	0.84	0.04	0.29	0.14	*0.89*	1.04
Other Asia	-0.51	0.10	-2.93	*0.00*	0.60	-0.01	0.17	-0.07	*0.95*	0.99
Rest of the World	-0.32	0.07	-3.46	*0.00*	0.73	0.17	0.11	1.81	*0.07*	1.19

Source: author's calculations based on ONS LS

Table D3 (continued).[51]

Model 2a (cause-specific)	Male					Female				
	Log Haz	S.E	Z-Score	P-value	Haz Ratio	Log Haz	S.E	Z-Score	P-value	Haz Ratio
Infectious diseases										
England and Wales	-3.75	0.00	-59.59	*0.00*	0.02	-3.31	0.00	-47.04	*0.00*	0.04
Scotland	-2.82	0.01	-11.25	*0.00*	0.06	-2.59	0.03	-7.77	*0.00*	0.07
Northern Ireland	-4.36	0.01	-4.36	*0.00*	0.01	-2.62	0.04	-4.53	*0.00*	0.07
Irish Republic	-4.07	0.01	-8.14	*0.00*	0.02	-2.97	0.02	-7.86	*0.00*	0.05
South Asian	-2.78	0.01	-15.45	*0.00*	0.06	-2.16	0.02	-10.10	*0.00*	0.12
Caribbean	-2.75	0.02	-8.71	*0.00*	0.06	-3.26	0.02	-5.65	*0.00*	0.04
African	-2.40	0.03	-7.96	*0.00*	0.09	-1.62	0.06	-5.37	*0.00*	0.20
European	-3.79	0.01	-9.28	*0.00*	0.02	-2.96	0.02	-9.35	*0.00*	0.05
Chinese	-4.51	0.01	-4.51	*0.00*	0.01	-3.87	0.02	-3.87	*0.00*	0.02
Rest of the World	-3.03	0.02	-8.58	*0.00*	0.05	-3.48	0.02	-6.02	*0.00*	0.03
Other Causes of death										
England and Wales	-0.54	0.01	-34.45	*0.00*	0.58	-0.32	0.01	-15.67	*0.00*	0.73
Scotland	-0.27	0.05	-3.76	*0.00*	0.77	0.02	0.09	0.26	*0.79*	1.02
Northern Ireland	-0.23	0.10	-1.83	*0.07*	0.79	-0.16	0.14	-0.95	*0.35*	0.85
Irish Republic	-0.55	0.05	-6.37	*0.00*	0.58	-0.18	0.08	-1.91	*0.06*	0.83
India	-0.63	0.04	-7.99	*0.00*	0.53	-0.28	0.08	-2.73	*0.01*	0.75
Pakistan	-1.13	0.05	-7.58	*0.00*	0.32	-0.57	0.11	-2.92	*0.00*	0.56
Bangladesh	-1.36	0.07	-5.08	*0.00*	0.26	-0.34	0.20	-1.23	*0.22*	0.71
Jamaica	-0.79	0.07	-5.14	*0.00*	0.46	-0.38	0.12	-2.19	*0.03*	0.68
Other Caribbean	-0.96	0.08	-4.70	*0.00*	0.38	-0.35	0.15	-1.60	*0.11*	0.71
East and South Africa	-0.69	0.08	-4.42	*0.00*	0.50	-0.07	0.15	-0.45	*0.65*	0.93
West and Central Africa	-0.59	0.12	-2.76	*0.01*	0.56	-0.67	0.18	-1.91	*0.06*	0.51
Western Europe	-0.77	0.05	-6.79	*0.00*	0.46	-0.73	0.06	-5.95	*0.00*	0.48
Eastern Europe	-0.80	0.07	-5.22	*0.00*	0.45	-0.62	0.10	-3.30	*0.00*	0.54
China	-0.74	0.12	-3.05	*0.00*	0.48	-1.43	0.14	-2.47	*0.01*	0.24
Other Asia	-1.12	0.08	-4.74	*0.00*	0.33	-0.68	0.12	-2.86	*0.00*	0.51
Rest of the World	-0.43	0.06	-4.45	*0.00*	0.65	-0.19	0.09	-1.70	*0.09*	0.83

Source: author's calculations based on ONS LS

[51] Male (constant) **0.000001630**; (SE) **0.00000005120**; (z-score) **-424.90**; (p-value) **0.00**; Male (gamma) **0.007654**; (SE) **0.0000395**; (z-score) **166.35**; (p-value) **0.00**; Female (constant) **0.000000609**; (SE) **0.00000002430**; (z-score) **-358.60**; (p-value) **0.00**; Female (gamma) **0.0081081**; (SE) **0.0000487**; (z-score) **166.38**; (p-value) **0.00**

Table D4. Model 2b from Chapter III with log relative hazard, standard errors, z-score and p-values (SES model).

Model 2b (cause-specific)	Male					Female				
	Log Haz	S.E	Z-Score	P-value	Haz Ratio	Log Haz	S.E	Z-Score	P-value	Haz Ratio
Period										
1971-1981	**0**				**1**	**0**				**1**
1981-1991	-0.09	0.03	-3.09	*0.00*	0.92	-0.11	0.03	-3.04	*0.00*	0.90
1991-2001	-0.24	0.02	-9.16	*0.00*	0.78	-0.19	0.03	-5.60	*0.00*	0.83
2001-2012	-0.41	0.02	-14.97	*0.00*	0.66	-0.19	0.03	-5.51	*0.00*	0.82
Country of birth by cause										
Cardiovascular diseases										
England and Wales	**0**				**1**	**0**				**1**
Scotland	0.21	0.07	3.66	*0.00*	1.23	0.28	0.11	3.49	*0.00*	1.32
Northern Ireland	0.09	0.11	0.85	*0.39*	1.09	0.19	0.17	1.39	*0.16*	1.21
Irish Republic	0.02	0.06	0.40	*0.69*	1.02	0.15	0.09	1.94	*0.05*	1.16
India	0.20	0.06	3.79	*0.00*	1.22	0.07	0.09	0.90	*0.37*	1.07
Pakistan	-0.09	0.08	-1.13	*0.26*	0.91	-0.04	0.12	-0.35	*0.72*	0.96
Bangladesh	0.17	0.13	1.51	*0.13*	1.19	-0.62	0.13	-2.47	*0.01*	0.54
Jamaica	-0.28	0.07	-2.84	*0.00*	0.76	0.23	0.14	2.05	*0.04*	1.26
Other Caribbean	-0.18	0.10	-1.43	*0.15*	0.84	-0.21	0.15	-1.12	*0.26*	0.81
East and South Africa	-0.35	0.09	-2.69	*0.01*	0.71	-0.40	0.12	-2.23	*0.03*	0.67
West and Central Africa	0.07	0.15	0.53	*0.60*	1.08	-0.40	0.19	-1.43	*0.15*	0.67
Western Europe	-0.24	0.07	-2.84	*0.00*	0.79	-0.20	0.07	-2.22	*0.03*	0.82
Eastern Europe	0.01	0.09	0.16	*0.87*	1.02	0.06	0.14	0.47	*0.64*	1.06
China	-0.14	0.15	-0.77	*0.44*	0.87	-0.40	0.21	-1.26	*0.21*	0.67
Other Asia	-0.57	0.10	-3.20	*0.00*	0.57	-0.55	0.12	-2.63	*0.01*	0.58
Rest of the World	-0.38	0.06	-4.13	*0.00*	0.68	-0.34	0.08	-2.91	*0.00*	0.71
Respiratory diseases										
England and Wales	-1.35	0.01	-64.29	*0.00*	0.26	-0.96	0.01	-38.11	*0.00*	0.38
Scotland	-1.04	0.04	-10.08	*0.00*	0.35	-0.45	0.07	-3.91	*0.00*	0.64
Northern Ireland	-1.00	0.07	-5.65	*0.00*	0.37	-0.69	0.11	-3.22	*0.00*	0.50
Irish Republic	-1.14	0.03	-11.20	*0.00*	0.32	-0.75	0.06	-6.38	*0.00*	0.47
South Asian	-1.82	0.02	-17.14	*0.00*	0.16	-1.40	0.03	-10.97	*0.00*	0.25
Caribbean	-2.22	0.02	-10.83	*0.00*	0.11	-1.42	0.05	-6.93	*0.00*	0.24
African	-2.27	0.03	-8.48	*0.00*	0.10	-1.56	0.06	-5.84	*0.00*	0.21
European	-2.21	0.02	-12.65	*0.00*	0.11	-1.58	0.03	-10.46	*0.00*	0.21
Chinese	-1.89	0.04	-7.08	*0.00*	0.15	-2.06	0.05	-5.44	*0.00*	0.13
Rest of the World	-1.50	0.04	-9.33	*0.00*	0.22	-1.24	0.05	-6.79	*0.00*	0.29
Cancers										
England and Wales	-0.04	0.01	-3.09	*0.00*	0.96	0.50	0.03	29.82	*0.00*	1.65
Scotland	0.19	0.07	3.30	*0.00*	1.21	0.72	0.13	11.21	*0.00*	2.06
Northern Ireland	0.22	0.12	2.23	*0.03*	1.24	0.41	0.19	3.32	*0.00*	1.51
Irish Republic	-0.01	0.06	-0.21	*0.84*	0.99	0.55	0.11	8.74	*0.00*	1.73
India	-0.92	0.04	-10.40	*0.00*	0.40	-0.28	0.07	-2.98	*0.00*	0.76
Pakistan	-0.84	0.05	-6.96	*0.00*	0.43	-0.34	0.10	-2.38	*0.02*	0.71
Bangladesh	-0.88	0.08	-4.64	*0.00*	0.41	-0.83	0.12	-2.97	*0.00*	0.44
Jamaica	-0.43	0.07	-4.09	*0.00*	0.65	0.28	0.15	2.54	*0.01*	1.32
Other Caribbean	-0.47	0.09	-3.30	*0.00*	0.63	-0.02	0.17	-0.12	*0.90*	0.98
East and South Africa	-0.70	0.08	-4.55	*0.00*	0.50	-0.10	0.14	-0.65	*0.51*	0.90
West and Central Africa	-0.53	0.11	-2.85	*0.00*	0.59	-0.40	0.19	-1.43	*0.15*	0.67
Western Europe	-0.37	0.06	-4.15	*0.00*	0.69	0.11	0.09	1.48	*0.14*	1.12
Eastern Europe	-0.32	0.08	-2.95	*0.00*	0.73	0.04	0.13	0.34	*0.74*	1.04
China	-0.20	0.15	-1.10	*0.27*	0.82	-0.14	0.24	-0.49	*0.62*	0.87
Other Asia	-0.54	0.10	-3.07	*0.00*	0.59	-0.13	0.15	-0.76	*0.45*	0.88
Rest of the World	-0.37	0.06	-3.99	*0.00*	0.69	0.10	0.10	1.06	*0.29*	1.10

Source: author's calculations based on ONS LS

Table D4 (continued).[52]

Model 2b (cause-specific)	**Male** Log Haz	S.E	Z-Score	P-value	Haz Ratio	**Female** Log Haz	S.E	Z-Score	P-value	Haz Ratio
Infectious diseases										
England and Wales	-3.75	0.00	-59.59	*0.00*	0.02	-3.31	0.00	-47.04	*0.00*	0.04
Scotland	-2.82	0.01	-11.25	*0.00*	0.06	-2.60	0.02	-7.81	*0.00*	0.07
Northern Ireland	-4.47	0.01	-4.47	*0.00*	0.01	-2.68	0.04	-4.64	*0.00*	0.07
Irish Republic	-4.34	0.01	-8.67	*0.00*	0.01	-3.11	0.02	-8.21	*0.00*	0.04
South Asian	-2.88	0.01	-16.02	*0.00*	0.06	-2.44	0.02	-11.41	*0.00*	0.09
Caribbean	-3.09	0.01	-9.77	*0.00*	0.05	-3.50	0.02	-6.06	*0.00*	0.03
African	-2.51	0.02	-8.32	*0.00*	0.08	-1.80	0.05	-5.98	*0.00*	0.16
European	-3.91	0.01	-9.58	*0.00*	0.02	-3.07	0.01	-9.69	*0.00*	0.05
Chinese	-4.53	0.01	-4.53	*0.00*	0.01	-4.00	0.02	-4.00	*0.00*	0.02
Rest of the World	-3.08	0.02	-8.71	*0.00*	0.05	-3.55	0.02	-6.14	*0.00*	0.03
Other Causes of death										
England and Wales	-0.54	0.01	-34.44	*0.00*	0.58	-0.32	0.01	-15.67	*0.00*	0.73
Scotland	-0.27	0.05	-3.76	*0.00*	0.77	0.01	0.09	0.11	*0.91*	1.01
Northern Ireland	-0.34	0.09	-2.67	*0.01*	0.71	-0.22	0.14	-1.32	*0.19*	0.80
Irish Republic	-0.82	0.04	-9.43	*0.00*	0.44	-0.32	0.07	-3.33	*0.00*	0.73
India	-0.70	0.04	-8.77	*0.00*	0.50	-0.48	0.06	-4.63	*0.00*	0.62
Pakistan	-1.28	0.04	-8.55	*0.00*	0.28	-0.98	0.07	-4.96	*0.00*	0.38
Bangladesh	-1.57	0.06	-5.88	*0.00*	0.21	-0.83	0.12	-2.97	*0.00*	0.44
Jamaica	-1.18	0.05	-7.72	*0.00*	0.31	-0.65	0.09	-3.74	*0.00*	0.52
Other Caribbean	-1.20	0.06	-5.88	*0.00*	0.30	-0.53	0.13	-2.43	*0.02*	0.59
East and South Africa	-0.74	0.07	-4.75	*0.00*	0.48	-0.25	0.13	-1.51	*0.13*	0.78
West and Central Africa	-0.81	0.10	-3.77	*0.00*	0.45	-0.88	0.15	-2.49	*0.01*	0.41
Western Europe	-0.84	0.05	-7.42	*0.00*	0.43	-0.83	0.05	-6.81	*0.00*	0.44
Eastern Europe	-1.00	0.06	-6.56	*0.00*	0.37	-0.73	0.09	-3.88	*0.00*	0.48
China	-0.77	0.11	-3.17	*0.00*	0.46	-1.60	0.12	-2.77	*0.01*	0.20
Other Asia	-1.14	0.08	-4.84	*0.00*	0.32	-0.79	0.11	-3.36	*0.00*	0.45
Rest of the World	-0.48	0.06	-4.94	*0.00*	0.62	-0.26	0.09	-2.33	*0.02*	0.77
Occupation Type										
Professional/Managerial	**0**				**1**	**0**				**1**
Skilled	0.17	0.02	11.39	*0.00*	1.19	0.03	0.02	1.28	*0.20*	1.03
Unskilled	0.35	0.02	20.51	*0.00*	1.42	0.30	0.03	12.70	*0.00*	1.35
Missing	0.83	0.04	44.47	*0.00*	2.30	0.64	0.04	28.58	*0.00*	1.90
Education Level										
Degree level	-0.40	0.01	-18.60	*0.00*	0.67	-0.37	0.02	-12.81	*0.00*	0.69
A-level	-0.22	0.02	-7.84	*0.00*	0.81	-0.24	0.03	-6.66	*0.00*	0.79
No 18+ qualificatons	**0**				**1**	**0**				**1**
Missing	1.40	0.13	43.56	*0.00*	4.07	1.63	0.19	42.82	*0.00*	5.11
Marital Status										
Married	**0**				**1**	**0**				**1**
Single	0.55	0.03	36.25	*0.00*	1.74	0.53	0.04	23.94	*0.00*	1.69
Divorced	0.37	0.03	20.40	*0.00*	1.44	0.30	0.03	14.43	*0.00*	1.35
Widowed	0.26	0.03	10.80	*0.00*	1.29	0.17	0.02	9.45	*0.00*	1.18
Missing	*(omitted)*					*(omitted)*				
Area of residence type										
Rural	**0**				**1**	**0**				**1**
London	0.08	0.02	4.44	*0.00*	1.08	0.05	0.02	2.33	*0.02*	1.05
Other Urban	0.14	0.01	10.53	*0.00*	1.15	0.14	0.02	9.34	*0.00*	1.15
Missing	*(omitted)*					*(omitted)*				

Source: author's calculations based on ONS LS

[52] Male (constant) **0.0000009840**; (SE) **0.00000003470**; (z-score) **-392.50**; (p-value) **0.00**; Male (gamma) **0.0079339**; (SE) **0.0000407**; (z-score) **194.89**; (p-value) **0.00**; Female (constant) **0.000000417**; (SE) **0.00000001900**; (z-score) **-322.06**; (p-value) **0.00**; Female (gamma) **0.0078987**; (SE) **0.0000512**; (z-score) **154.29**; (p-value) **0.00**

Table D5. Risk-time and death events (males).

<table>
<tr><th>Country of Birth</th><th>Risk Time</th><th>%</th><th colspan="2">All-cause</th><th colspan="2">Cardiovascular</th><th colspan="2">Cancers</th><th colspan="2">Respiratory</th><th colspan="2">Infectious</th><th colspan="2">Other causes</th></tr>
<tr><th></th><th></th><th></th><th>Events</th><th>%</th><th>Events</th><th>%</th><th>Events</th><th>%</th><th>Events</th><th>%</th><th>Events</th><th>%</th><th>Events</th><th>%</th></tr>
<tr><td>England and Wales</td><td>5,676,423</td><td>85.6</td><td>31,064</td><td>85.8</td><td>11,004</td><td>30.3</td><td>10,550</td><td>29.1</td><td>2,848</td><td>7.9</td><td>258</td><td>0.7</td><td>6,404</td><td>17.7</td></tr>
<tr><td>Scotland</td><td>120,546</td><td>1.8</td><td>965</td><td>2.6</td><td>328</td><td>0.9</td><td>322</td><td>0.9</td><td>94</td><td>0.3</td><td>16</td><td>0.0</td><td>205</td><td>0.6</td></tr>
<tr><td>Northern Ireland</td><td>34,539</td><td>0.5</td><td>298</td><td>0.8</td><td>95</td><td>0.3</td><td>108</td><td>0.3</td><td>32</td><td>0.1</td><td><10</td><td>0.0</td><td>62</td><td>0.2</td></tr>
<tr><td>Republic of Ireland</td><td>81,643</td><td>1.2</td><td>852</td><td>2.4</td><td>313</td><td>0.9</td><td>302</td><td>0.8</td><td>98</td><td>0.3</td><td><10</td><td>0.0</td><td>135</td><td>0.4</td></tr>
<tr><td>India</td><td>134,752</td><td>2.0</td><td>765</td><td>1.9</td><td>395</td><td>1.1</td><td>129</td><td>0.4</td><td rowspan="3">90</td><td rowspan="3">0.2</td><td rowspan="3">31</td><td rowspan="3">0.1</td><td>162</td><td>0.4</td></tr>
<tr><td>Pakistan</td><td>89,721</td><td>1.4</td><td>289</td><td>0.7</td><td>147</td><td>0.4</td><td>70</td><td>0.2</td><td>45</td><td>0.1</td></tr>
<tr><td>Bangladesh</td><td>35,646</td><td>0.5</td><td>137</td><td>0.3</td><td>80</td><td>0.2</td><td>28</td><td>0.1</td><td>14</td><td>0.0</td></tr>
<tr><td>Jamaica</td><td>30,886</td><td>0.5</td><td>259</td><td>0.8</td><td>106</td><td>0.3</td><td>91</td><td>0.3</td><td rowspan="2">24</td><td rowspan="2">0.1</td><td rowspan="2">10</td><td rowspan="2">0.0</td><td>43</td><td>0.1</td></tr>
<tr><td>Other Caribbean</td><td>24,458</td><td>0.4</td><td>156</td><td>0.4</td><td>67</td><td>0.2</td><td>50</td><td>0.1</td><td>24</td><td>0.1</td></tr>
<tr><td>East and Southern Africa</td><td>62,227</td><td>0.9</td><td>162</td><td>0.5</td><td>61</td><td>0.2</td><td>43</td><td>0.1</td><td rowspan="2">14</td><td rowspan="2">0.0</td><td rowspan="2">11</td><td rowspan="2">0.0</td><td>41</td><td>0.1</td></tr>
<tr><td>West and Central Africa</td><td>29,126</td><td>0.4</td><td>112</td><td>0.2</td><td>53</td><td>0.1</td><td>29</td><td>0.1</td><td>22</td><td>0.1</td></tr>
<tr><td>Western Europe</td><td>91,635</td><td>1.4</td><td>372</td><td>1.3</td><td>144</td><td>0.4</td><td>126</td><td>0.3</td><td rowspan="2">33</td><td rowspan="2">0.1</td><td rowspan="2">6</td><td rowspan="2">0.0</td><td>79</td><td>0.2</td></tr>
<tr><td>Eastern Europe</td><td>37,745</td><td>0.6</td><td>263</td><td>0.7</td><td>119</td><td>0.3</td><td>85</td><td>0.2</td><td>43</td><td>0.1</td></tr>
<tr><td>China</td><td>20,579</td><td>0.3</td><td>88</td><td>0.2</td><td>32</td><td>0.1</td><td>30</td><td>0.1</td><td rowspan="2">14</td><td rowspan="2">0.0</td><td rowspan="2"><10</td><td rowspan="2">0.0</td><td>17</td><td>0.0</td></tr>
<tr><td>Other Asia</td><td>40,446</td><td>0.6</td><td>89</td><td>0.3</td><td>32</td><td>0.1</td><td>33</td><td>0.1</td><td>18</td><td>0.0</td></tr>
<tr><td>Rest of the World</td><td>120,059</td><td>1.8</td><td>395</td><td>1.1</td><td>119</td><td>0.3</td><td>121</td><td>0.3</td><td>39</td><td>0.1</td><td>8</td><td>0.0</td><td>108</td><td>0.3</td></tr>
<tr><td>Total</td><td>6,630,431</td><td>100</td><td>36,266</td><td>100</td><td>13,095</td><td>36.1</td><td>12,117</td><td>33.4</td><td>3,286</td><td>9.1</td><td>346</td><td>1.0</td><td>7,422</td><td>20.5</td></tr>
</table>

Source: author's calculations based on ONS LS

Table D6. Risk-time and death events (females).

<table>
<tr><th>Country of Birth</th><th>Risk Time</th><th>%</th><th colspan="2">All-cause</th><th colspan="2">Cardiovascular</th><th colspan="2">Cancers</th><th colspan="2">Respiratory</th><th colspan="2">Infectious</th><th colspan="2">Other causes</th></tr>
<tr><th></th><th></th><th></th><th>Events</th><th>%</th><th>Events</th><th>%</th><th>Events</th><th>%</th><th>Events</th><th>%</th><th>Events</th><th>%</th><th>Events</th><th>%</th></tr>
<tr><td>England and Wales</td><td>5,734,915</td><td>85.0</td><td>21,729</td><td>85.8</td><td>5,724</td><td>22.6</td><td>9,434</td><td>37.3</td><td>2,201</td><td>8.7</td><td>210</td><td>0.8</td><td>4,160</td><td>16.5</td></tr>
<tr><td>Scotland</td><td>110,289</td><td>1.6</td><td>622</td><td>2.6</td><td>161</td><td>0.6</td><td>251</td><td>1.0</td><td>78</td><td>0.3</td><td>9</td><td>0.0</td><td>123</td><td>0.5</td></tr>
<tr><td>Northern Ireland</td><td>34,197</td><td>0.5</td><td>179</td><td>0.8</td><td>53</td><td>0.2</td><td>66</td><td>0.3</td><td>22</td><td>0.1</td><td><10</td><td>0.0</td><td>35</td><td>0.1</td></tr>
<tr><td>Republic of Ireland</td><td>93,543</td><td>1.4</td><td>646</td><td>2.4</td><td>181</td><td>0.7</td><td>270</td><td>1.1</td><td>74</td><td>0.3</td><td>7</td><td>0.0</td><td>114</td><td>0.5</td></tr>
<tr><td>India</td><td>131,192</td><td>1.9</td><td>434</td><td>1.9</td><td>165</td><td>0.7</td><td>116</td><td>0.5</td><td rowspan="3">62</td><td rowspan="3">0.2</td><td rowspan="3">22</td><td rowspan="3">0.1</td><td>95</td><td>0.4</td></tr>
<tr><td>Pakistan</td><td>70,994</td><td>1.1</td><td>163</td><td>0.7</td><td>66</td><td>0.3</td><td>49</td><td>0.2</td><td>26</td><td>0.1</td></tr>
<tr><td>Bangladesh</td><td>35,564</td><td>0.5</td><td>46</td><td>0.3</td><td>16</td><td>0.1</td><td>13</td><td>0.1</td><td>13</td><td>0.1</td></tr>
<tr><td>Jamaica</td><td>34,949</td><td>0.5</td><td>216</td><td>0.8</td><td>80</td><td>0.3</td><td>84</td><td>0.3</td><td rowspan="2">24</td><td rowspan="2">0.1</td><td rowspan="2"><10</td><td rowspan="2">0.0</td><td>33</td><td>0.1</td></tr>
<tr><td>Other Caribbean</td><td>26,909</td><td>0.4</td><td>93</td><td>0.4</td><td>29</td><td>0.1</td><td>35</td><td>0.1</td><td>21</td><td>0.1</td></tr>
<tr><td>East and Southern Africa</td><td>66,851</td><td>1.0</td><td>133</td><td>0.5</td><td>32</td><td>0.1</td><td>43</td><td>0.2</td><td rowspan="2">14</td><td rowspan="2">0.1</td><td rowspan="2">11</td><td rowspan="2">0.0</td><td>37</td><td>0.1</td></tr>
<tr><td>West and Central Africa</td><td>30,181</td><td>0.4</td><td>38</td><td>0.2</td><td>13</td><td>0.1</td><td>13</td><td>0.1</td><td>8</td><td>0.0</td></tr>
<tr><td>Western Europe</td><td>120,157</td><td>1.8</td><td>413</td><td>1.3</td><td>128</td><td>0.5</td><td>175</td><td>0.7</td><td rowspan="2">44</td><td rowspan="2">0.2</td><td rowspan="2">10</td><td rowspan="2">0.0</td><td>68</td><td>0.3</td></tr>
<tr><td>Eastern Europe</td><td>50,573</td><td>0.7</td><td>163</td><td>0.7</td><td>62</td><td>0.2</td><td>61</td><td>0.2</td><td>28</td><td>0.1</td></tr>
<tr><td>China</td><td>19,690</td><td>0.3</td><td>29</td><td>0.2</td><td>10</td><td>0.0</td><td>13</td><td>0.1</td><td rowspan="2">7</td><td rowspan="2">0.0</td><td rowspan="2"><10</td><td rowspan="2">0.0</td><td>3</td><td>0.0</td></tr>
<tr><td>Other Asia</td><td>54,465</td><td>0.8</td><td>81</td><td>0.3</td><td>23</td><td>0.1</td><td>35</td><td>0.1</td><td>18</td><td>0.1</td></tr>
<tr><td>Rest of the World</td><td>129,223</td><td>1.9</td><td>302</td><td>1.1</td><td>74</td><td>0.3</td><td>115</td><td>0.5</td><td>30</td><td>0.1</td><td><10</td><td>0.0</td><td>80</td><td>0.3</td></tr>
<tr><td>Total</td><td>6,743,692</td><td>100</td><td>25,287</td><td>100</td><td>6,817</td><td>27.0</td><td>10,773</td><td>42.6</td><td>2,556</td><td>10.1</td><td>279</td><td>1.0</td><td>4,862</td><td>19.2</td></tr>
</table>

Source: author’s calculations based on ONS LS

Table D7. Comparison and interaction models for cardiovascular disease.[53]

Cardiovascular	Comparison Model					Interaction Model				
	Log Haz	Std Error	Z-score	P-value	Haz Ratio	Log Haz	Std Error	Z-score	P-value	Haz Ratio
Country of birth										
England and Wales-born	**0**				**1**	**0**				**1**
South Asian	0.15	0.04	3.99	*0.00*	1.16	0.17	0.13	1.30	0.19	1.18
Caribbean & African	-0.10	0.05	-1.94	*0.05*	0.90	-0.08	0.13	-0.62	0.53	0.92
Chinese	-0.14	0.04	-3.35	*0.00*	0.87	-0.12	0.13	-0.91	0.36	0.89
Other	-0.29	0.08	-2.79	*0.01*	0.74	-0.28	0.16	-1.73	0.08	0.76
Sex										
Male	**0**				**1**	**0**				**1**
Female	-0.93	0.01	-57.11	*0.00*	0.40	-0.93	0.02	-57.11	0.00	0.40
Period										
1971-1981	**0**				**1**	**0**				**1**
1981-1991	-0.12	0.04	-3.08	*0.00*	0.88	-0.12	0.04	-3.08	0.00	0.88
1991-2001	-0.48	0.02	-12.07	*0.00*	0.62	-0.48	0.04	-12.07	0.00	0.62
2001-2011	-0.96	0.02	-23.07	*0.00*	0.38	-0.96	0.04	-23.07	0.00	0.38
Occupation Type										
Professional/Managerial	**0**				**1**	**0**				**1**
Skilled	0.17	0.03	7.63	*0.00*	1.18	0.17	0.02	7.63	0.00	1.18
Unskilled	0.38	0.04	15.83	*0.00*	1.47	0.38	0.02	15.83	0.00	1.47
Missing	0.77	0.05	31.31	*0.00*	2.17	0.77	0.02	31.31	0.00	2.17
Education level										
Degree level +	-0.39	0.02	-12.54	*0.00*	0.68	-0.39	0.03	-12.54	0.00	0.68
A-level	-0.22	0.03	-5.55	*0.00*	0.80	-0.22	0.04	-5.55	0.00	0.80
No 18+ qualifications	-0.22	0.03	-5.55	*0.00*	0.80	-0.22	0.04	-5.55	0.00	0.80
Marital Status										
Married	**0**				**1**	**0**				**1**
Single	0.52	0.04	22.91	*0.00*	1.68	0.52	0.02	22.91	0.00	1.68
Divorced	0.40	0.04	16.70	*0.00*	1.50	0.40	0.02	16.70	0.00	1.50
Widowed	0.27	0.03	11.47	*0.00*	1.32	0.27	0.02	11.47	0.00	1.32
Area of residence type										
London	**0**				**1**	**0**				**1**
Other Urban	0.02	0.02	0.64	*0.53*	1.02	0.01	0.02	0.64	0.53	1.02
Rural	0.18	0.02	10.39	*0.00*	1.19	0.18	0.02	10.39	0.00	1.19

Source: author's calculations based on ONS LS

Interaction term: -0.00002460

Likelihood ratio test (assumption comparison model nested in interaction model)

LR $chi^2(1) = 0.02$; Prob > $chi^2 = 0.8759$

[53] Comparison (constant) **0.000000313**; (SE) **0.0000000164**; (z-score) **-286.40**; (p-value) **0.00**; Comparison (gamma) **0.0099433**; (SE) **0.0000648**; (z-score) **153.39**; (p-value) **0.00**; Interaction (constant) **-14.97902**; (SE) **0.0536865**; (z-score) **-279.01**; (p-value) **0.00**; Interaction (gamma – immigrant) **-0.0000246**; (SE) **0.0001575**; (z-score) **-0.16**; (p-value) **0.88**; Interaction (gamma – constant) **0.0099459**; (SE) **0.0000669**; (z-score) **148.58**; (p-value) **0.00**

Table D8. Values used to plot Figure 3 calculated from interaction model (Table D7).

Age years	England and Wales-born			South Asian			Caribbean & African			Chinese & Other Asian			European & Other		
	Log Hazard	Hazard Rate	Haz Ratio	Log Hazard	Hazard Rate	Haz Ratio	Log Hazard	Hazard Rate	Haz Ratio	Log Hazard	Hazard Rate	Haz Ratio	Log Hazard	Hazard Rate	Haz Ratio
Start	-12.49	*0.0000*	**1.00**	-12.33	*0.0000*	**1.18**	-12.57	*0.0000*	**0.92**	-12.61	*0.0000*	**0.89**	-12.77	*0.0000*	**0.76**
20	-10.11	*0.0000*	**1.00**	-9.95	*0.0000*	**1.17**	-10.19	*0.0000*	**0.92**	-10.23	*0.0000*	**0.88**	-10.39	*0.0000*	**0.75**
21	-9.99	*0.0000*	**1.00**	-9.83	*0.0001*	**1.17**	-10.07	*0.0000*	**0.92**	-10.11	*0.0000*	**0.88**	-10.27	*0.0000*	**0.75**
22	-9.87	*0.0001*	**1.00**	-9.71	*0.0001*	**1.17**	-9.96	*0.0000*	**0.92**	-9.99	*0.0000*	**0.88**	-10.15	*0.0000*	**0.75**
23	-9.75	*0.0001*	**1.00**	-9.59	*0.0001*	**1.17**	-9.84	*0.0001*	**0.91**	-9.87	*0.0001*	**0.88**	-10.03	*0.0000*	**0.75**
24	-9.63	*0.0001*	**1.00**	-9.47	*0.0001*	**1.17**	-9.72	*0.0001*	**0.91**	-9.75	*0.0001*	**0.88**	-9.91	*0.0000*	**0.75**
25	-9.51	*0.0001*	**1.00**	-9.35	*0.0001*	**1.17**	-9.60	*0.0001*	**0.91**	-9.64	*0.0001*	**0.88**	-9.79	*0.0001*	**0.75**
26	-9.39	*0.0001*	**1.00**	-9.23	*0.0001*	**1.17**	-9.48	*0.0001*	**0.91**	-9.52	*0.0001*	**0.88**	-9.67	*0.0001*	**0.75**
27	-9.27	*0.0001*	**1.00**	-9.11	*0.0001*	**1.17**	-9.36	*0.0001*	**0.91**	-9.40	*0.0001*	**0.88**	-9.55	*0.0001*	**0.75**
28	-9.15	*0.0001*	**1.00**	-8.99	*0.0001*	**1.17**	-9.24	*0.0001*	**0.91**	-9.28	*0.0001*	**0.88**	-9.43	*0.0001*	**0.75**
29	-9.03	*0.0001*	**1.00**	-8.87	*0.0001*	**1.17**	-9.12	*0.0001*	**0.91**	-9.16	*0.0001*	**0.88**	-9.31	*0.0001*	**0.75**
30	-8.91	*0.0001*	**1.00**	-8.76	*0.0002*	**1.17**	-9.00	*0.0001*	**0.91**	-9.04	*0.0001*	**0.88**	-9.20	*0.0001*	**0.75**
31	-8.79	*0.0002*	**1.00**	-8.64	*0.0002*	**1.17**	-8.88	*0.0001*	**0.91**	-8.92	*0.0001*	**0.88**	-9.08	*0.0001*	**0.75**
32	-8.67	*0.0002*	**1.00**	-8.52	*0.0002*	**1.17**	-8.76	*0.0002*	**0.91**	-8.80	*0.0002*	**0.88**	-8.96	*0.0001*	**0.75**
33	-8.55	*0.0002*	**1.00**	-8.40	*0.0002*	**1.17**	-8.65	*0.0002*	**0.91**	-8.68	*0.0002*	**0.88**	-8.84	*0.0001*	**0.75**
34	-8.43	*0.0002*	**1.00**	-8.28	*0.0003*	**1.17**	-8.53	*0.0002*	**0.91**	-8.56	*0.0002*	**0.88**	-8.72	*0.0002*	**0.75**
35	-8.31	*0.0002*	**1.00**	-8.16	*0.0003*	**1.17**	-8.41	*0.0002*	**0.91**	-8.44	*0.0002*	**0.88**	-8.60	*0.0002*	**0.75**
36	-8.20	*0.0003*	**1.00**	-8.04	*0.0003*	**1.17**	-8.29	*0.0003*	**0.91**	-8.33	*0.0002*	**0.88**	-8.48	*0.0002*	**0.75**
37	-8.08	*0.0003*	**1.00**	-7.92	*0.0004*	**1.17**	-8.17	*0.0003*	**0.91**	-8.21	*0.0003*	**0.88**	-8.36	*0.0002*	**0.75**
38	-7.96	*0.0004*	**1.00**	-7.80	*0.0004*	**1.17**	-8.05	*0.0003*	**0.91**	-8.09	*0.0003*	**0.88**	-8.24	*0.0003*	**0.75**
39	-7.84	*0.0004*	**1.00**	-7.68	*0.0005*	**1.17**	-7.93	*0.0004*	**0.91**	-7.97	*0.0003*	**0.88**	-8.12	*0.0003*	**0.75**
40	-7.72	*0.0004*	**1.00**	-7.56	*0.0005*	**1.17**	-7.81	*0.0004*	**0.91**	-7.85	*0.0004*	**0.88**	-8.01	*0.0003*	**0.75**
41	-7.60	*0.0005*	**1.00**	-7.45	*0.0006*	**1.17**	-7.69	*0.0005*	**0.91**	-7.73	*0.0004*	**0.88**	-7.89	*0.0004*	**0.75**
42	-7.48	*0.0006*	**1.00**	-7.33	*0.0007*	**1.17**	-7.57	*0.0005*	**0.91**	-7.61	*0.0005*	**0.88**	-7.77	*0.0004*	**0.75**
43	-7.36	*0.0006*	**1.00**	-7.21	*0.0007*	**1.16**	-7.46	*0.0006*	**0.91**	-7.49	*0.0006*	**0.88**	-7.65	*0.0005*	**0.75**
44	-7.24	*0.0007*	**1.00**	-7.09	*0.0008*	**1.16**	-7.34	*0.0007*	**0.91**	-7.37	*0.0006*	**0.88**	-7.53	*0.0005*	**0.75**
45	-7.12	*0.0008*	**1.00**	-6.97	*0.0009*	**1.16**	-7.22	*0.0007*	**0.91**	-7.25	*0.0007*	**0.88**	-7.41	*0.0006*	**0.75**
46	-7.00	*0.0009*	**1.00**	-6.85	*0.0011*	**1.16**	-7.10	*0.0008*	**0.91**	-7.13	*0.0008*	**0.88**	-7.29	*0.0007*	**0.75**
47	-6.88	*0.0010*	**1.00**	-6.73	*0.0012*	**1.16**	-6.98	*0.0009*	**0.91**	-7.02	*0.0009*	**0.88**	-7.17	*0.0008*	**0.75**
48	-6.76	*0.0012*	**1.00**	-6.61	*0.0013*	**1.16**	-6.86	*0.0010*	**0.91**	-6.90	*0.0010*	**0.87**	-7.05	*0.0009*	**0.75**
49	-6.64	*0.0013*	**1.00**	-6.49	*0.0015*	**1.16**	-6.74	*0.0012*	**0.91**	-6.78	*0.0011*	**0.87**	-6.93	*0.0010*	**0.75**
50	-6.52	*0.0015*	**1.00**	-6.37	*0.0017*	**1.16**	-6.62	*0.0013*	**0.91**	-6.66	*0.0013*	**0.87**	-6.81	*0.0011*	**0.75**
51	-6.41	*0.0017*	**1.00**	-6.26	*0.0019*	**1.16**	-6.50	*0.0015*	**0.91**	-6.54	*0.0014*	**0.87**	-6.70	*0.0012*	**0.75**
52	-6.29	*0.0019*	**1.00**	-6.14	*0.0022*	**1.16**	-6.38	*0.0017*	**0.91**	-6.42	*0.0016*	**0.87**	-6.58	*0.0014*	**0.75**
53	-6.17	*0.0021*	**1.00**	-6.02	*0.0024*	**1.16**	-6.26	*0.0019*	**0.91**	-6.30	*0.0018*	**0.87**	-6.46	*0.0016*	**0.75**
54	-6.05	*0.0024*	**1.00**	-5.90	*0.0027*	**1.16**	-6.15	*0.0021*	**0.91**	-6.18	*0.0021*	**0.87**	-6.34	*0.0018*	**0.75**
55	-5.93	*0.0027*	**1.00**	-5.78	*0.0031*	**1.16**	-6.03	*0.0024*	**0.91**	-6.06	*0.0023*	**0.87**	-6.22	*0.0020*	**0.75**
56	-5.81	*0.0030*	**1.00**	-5.66	*0.0035*	**1.16**	-5.91	*0.0027*	**0.91**	-5.94	*0.0026*	**0.87**	-6.10	*0.0022*	**0.75**
57	-5.69	*0.0034*	**1.00**	-5.54	*0.0039*	**1.16**	-5.79	*0.0031*	**0.91**	-5.83	*0.0030*	**0.87**	-5.98	*0.0025*	**0.75**
58	-5.57	*0.0038*	**1.00**	-5.42	*0.0044*	**1.16**	-5.67	*0.0035*	**0.91**	-5.71	*0.0033*	**0.87**	-5.86	*0.0028*	**0.75**
59	-5.45	*0.0043*	**1.00**	-5.30	*0.0050*	**1.16**	-5.55	*0.0039*	**0.91**	-5.59	*0.0037*	**0.87**	-5.74	*0.0032*	**0.75**
60	-5.33	*0.0048*	**1.00**	-5.18	*0.0056*	**1.16**	-5.43	*0.0044*	**0.90**	-5.47	*0.0042*	**0.87**	-5.62	*0.0036*	**0.75**
61	-5.21	*0.0055*	**1.00**	-5.06	*0.0063*	**1.16**	-5.31	*0.0049*	**0.90**	-5.35	*0.0048*	**0.87**	-5.51	*0.0041*	**0.75**
62	-5.09	*0.0061*	**1.00**	-4.95	*0.0071*	**1.16**	-5.19	*0.0056*	**0.90**	-5.23	*0.0054*	**0.87**	-5.39	*0.0046*	**0.75**
63	-4.97	*0.0069*	**1.00**	-4.83	*0.0080*	**1.16**	-5.07	*0.0063*	**0.90**	-5.11	*0.0060*	**0.87**	-5.27	*0.0052*	**0.75**
64	-4.85	*0.0078*	**1.00**	-4.71	*0.0090*	**1.16**	-4.95	*0.0070*	**0.90**	-4.99	*0.0068*	**0.87**	-5.15	*0.0058*	**0.75**
65	-4.73	*0.0088*	**1.00**	-4.59	*0.0102*	**1.16**	-4.84	*0.0079*	**0.90**	-4.87	*0.0077*	**0.87**	-5.03	*0.0065*	**0.74**
66	-4.62	*0.0099*	**1.00**	-4.47	*0.0115*	**1.16**	-4.72	*0.0089*	**0.90**	-4.75	*0.0086*	**0.87**	-4.91	*0.0074*	**0.74**
67	-4.50	*0.0112*	**1.00**	-4.35	*0.0129*	**1.16**	-4.60	*0.0101*	**0.90**	-4.63	*0.0097*	**0.87**	-4.79	*0.0083*	**0.74**
68	-4.38	*0.0126*	**1.00**	-4.23	*0.0145*	**1.16**	-4.48	*0.0113*	**0.90**	-4.52	*0.0109*	**0.87**	-4.67	*0.0094*	**0.74**
69	-4.26	*0.0142*	**1.00**	-4.11	*0.0164*	**1.16**	-4.36	*0.0128*	**0.90**	-4.40	*0.0123*	**0.87**	-4.55	*0.0105*	**0.74**
70	-4.14	*0.0160*	**1.00**	-3.99	*0.0184*	**1.16**	-4.24	*0.0144*	**0.90**	-4.28	*0.0139*	**0.87**	-4.43	*0.0119*	**0.74**
71	-4.02	*0.0180*	**1.00**	-3.87	*0.0208*	**1.16**	-4.12	*0.0162*	**0.90**	-4.16	*0.0156*	**0.87**	-4.31	*0.0134*	**0.74**
72	-3.90	*0.0203*	**1.00**	-3.75	*0.0234*	**1.15**	-4.00	*0.0183*	**0.90**	-4.04	*0.0176*	**0.87**	-4.20	*0.0151*	**0.74**
73	-3.78	*0.0228*	**1.00**	-3.64	*0.0264*	**1.15**	-3.88	*0.0206*	**0.90**	-3.92	*0.0198*	**0.87**	-4.08	*0.0170*	**0.74**
74	-3.66	*0.0257*	**1.00**	-3.52	*0.0297*	**1.15**	-3.76	*0.0232*	**0.90**	-3.80	*0.0223*	**0.87**	-3.96	*0.0191*	**0.74**
75	-3.54	*0.0290*	**1.00**	-3.40	*0.0334*	**1.15**	-3.65	*0.0261*	**0.90**	-3.68	*0.0252*	**0.87**	-3.84	*0.0215*	**0.74**
76	-3.42	*0.0327*	**1.00**	-3.28	*0.0377*	**1.15**	-3.53	*0.0294*	**0.90**	-3.56	*0.0283*	**0.87**	-3.72	*0.0243*	**0.74**
77	-3.30	*0.0368*	**1.00**	-3.16	*0.0424*	**1.15**	-3.41	*0.0331*	**0.90**	-3.44	*0.0319*	**0.87**	-3.60	*0.0273*	**0.74**
78	-3.18	*0.0415*	**1.00**	-3.04	*0.0478*	**1.15**	-3.29	*0.0373*	**0.90**	-3.33	*0.0360*	**0.87**	-3.48	*0.0308*	**0.74**
79	-3.06	*0.0467*	**1.00**	-2.92	*0.0539*	**1.15**	-3.17	*0.0420*	**0.90**	-3.21	*0.0405*	**0.87**	-3.36	*0.0347*	**0.74**
80	-2.94	*0.0526*	**1.00**	-2.80	*0.0607*	**1.15**	-3.05	*0.0474*	**0.90**	-3.09	*0.0456*	**0.87**	-3.24	*0.0390*	**0.74**

Source: author's calculations based on ONS LS

Table D9. Comparison and interaction models for cancer.[54]

Cancer	Comparison Model					Interaction Model				
	Log Haz	Std Error	Z-score	P-value	Haz Ratio	Log Haz	Std Error	Z-score	P-value	Haz Ratio
Country of birth										
England and Wales-born	**0**				**1**	**0**				**1**
South Asian	-0.79	0.02	-15.07	*0.00*	0.45	-1.06	0.14	-7.69	*0.00*	0.35
Caribbean & African	-0.38	0.04	-6.93	*0.00*	0.68	-0.65	0.14	-4.67	*0.00*	0.52
Chinese	-0.31	0.03	-7.74	*0.00*	0.73	-0.59	0.14	-4.29	*0.00*	0.56
Other	-0.44	0.06	-4.46	*0.00*	0.64	-0.70	0.16	-4.41	*0.00*	0.50
Sex										
Male	**0**				**1**	**0**				**1**
Female	-0.27	0.01	-18.88	*0.00*	0.77	-0.27	0.01	-18.86	*0.00*	0.77
Period										
1971-1981	**0**				**1**	**0**				**1**
1981-1991	0.06	0.04	1.56	*0.12*	1.06	0.06	0.04	1.59	*0.11*	1.06
1991-2001	-0.04	0.04	-0.98	*0.33*	0.96	-0.03	0.04	-0.94	*0.35*	0.97
2001-2011	-0.22	0.03	-5.75	*0.00*	0.80	-0.22	0.04	-5.68	*0.00*	0.80
Occupation Type										
Professional/Managerial	**0**				**1**	**0**				**1**
Skilled	0.08	0.02	4.09	*0.00*	1.08	0.08	0.02	4.09	*0.00*	1.08
Unskilled	0.24	0.03	10.79	*0.00*	1.27	0.24	0.02	10.79	*0.00*	1.27
Missing	0.36	0.03	15.56	*0.00*	1.44	0.36	0.02	15.54	*0.00*	1.44
Education level										
Degree level +	-0.29	0.02	-10.71	*0.00*	0.75	-0.29	0.03	-10.69	*0.00*	0.75
A-level	-0.14	0.03	-4.13	*0.00*	0.87	-0.14	0.03	-4.13	*0.00*	0.87
No 18+ qualifications	**0**				**1**	**0**				**1**
Marital Status										
Married	**0**				**1**	**0**				**1**
Single	0.09	0.03	3.84	*0.00*	1.09	0.09	0.02	3.79	*0.00*	1.09
Divorced	0.19	0.03	8.35	*0.00*	1.21	0.19	0.02	8.30	*0.00*	1.21
Widowed	-0.05	0.02	-1.92	*0.06*	0.96	-0.05	0.02	-1.94	*0.05*	0.95
Area of residence type										
London	**0**				**1**	**0**				**1**
Other Urban	0.09	0.02	4.22	*0.00*	1.10	0.09	0.02	4.23	*0.00*	1.10
Rural	0.11	0.02	6.77	*0.00*	1.12	0.11	0.02	6.76	*0.00*	1.12

Source: author's calculations based on ONS LS

Interaction term: 0.00035570

Likelihood ratio test (assumption comparison model nested in interaction model)

LR $chi^2(1) = 4.45$; Prob > $chi^2 = 0.0349$

[54] Comparison (constant) **0.000000871**; (SE) **0.0000000413**; (z-score) **-294.54**; (p-value) **0.00**; Comparison (gamma) **0.0081037**; (SE) **0.0000551**; (z-score) **147.12**; (p-value) **0.00**; Interaction (constant) **-13.93548**; (SE) **0.0481118**; (z-score) **-289.65**; (p-value) **0.00**; Interaction (gamma – immigrant) **0.0003557**; (SE) **0.0001695**; (z-score) **2.10**; (p-value) **0.036**; Interaction (gamma – constant) **0.0080774**; (SE) **0.0000565**; (z-score) **143.09**; (p-value) **0.00**

Table D10. Values used to plot Figure 3 calculated from interaction model (Table 9).

Age years	England and Wales-born			South Asian			Caribbean & African			Chinese & Other Asian			European & Other		
	Log Hazard	Hazard Rate	Haz Ratio	Log Hazard	Hazard Rate	Haz Ratio	Log Hazard	Hazard Rate	Haz Ratio	Log Hazard	Hazard Rate	Haz Ratio	Log Hazard	Hazard Rate	Haz Ratio
Start	-11.47	*0.0000*	**1.00**	-12.53	*0.0000*	**0.35**	-12.12	*0.0000*	**0.52**	-12.06	*0.0000*	**0.56**	-12.17	*0.0000*	**0.50**
20	-9.53	*0.0001*	**1.00**	-10.50	*0.0000*	**0.38**	-10.09	*0.0000*	**0.57**	-10.03	*0.0000*	**0.61**	-10.14	*0.0000*	**0.54**
21	-9.43	*0.0001*	**1.00**	-10.40	*0.0000*	**0.38**	-9.99	*0.0000*	**0.57**	-9.93	*0.0000*	**0.61**	-10.04	*0.0000*	**0.54**
22	-9.34	*0.0001*	**1.00**	-10.30	*0.0000*	**0.38**	-9.89	*0.0001*	**0.57**	-9.83	*0.0001*	**0.61**	-9.94	*0.0000*	**0.55**
23	-9.24	*0.0001*	**1.00**	-10.20	*0.0000*	**0.38**	-9.79	*0.0001*	**0.58**	-9.73	*0.0001*	**0.61**	-9.84	*0.0001*	**0.55**
24	-9.14	*0.0001*	**1.00**	-10.10	*0.0000*	**0.39**	-9.69	*0.0001*	**0.58**	-9.63	*0.0001*	**0.62**	-9.74	*0.0001*	**0.55**
25	-9.05	*0.0001*	**1.00**	-10.00	*0.0000*	**0.39**	-9.59	*0.0001*	**0.58**	-9.53	*0.0001*	**0.62**	-9.64	*0.0001*	**0.55**
26	-8.95	*0.0001*	**1.00**	-9.89	*0.0001*	**0.39**	-9.49	*0.0001*	**0.58**	-9.42	*0.0001*	**0.62**	-9.54	*0.0001*	**0.56**
27	-8.85	*0.0001*	**1.00**	-9.79	*0.0001*	**0.39**	-9.38	*0.0001*	**0.59**	-9.32	*0.0001*	**0.62**	-9.44	*0.0001*	**0.56**
28	-8.75	*0.0002*	**1.00**	-9.69	*0.0001*	**0.39**	-9.28	*0.0001*	**0.59**	-9.22	*0.0001*	**0.63**	-9.33	*0.0001*	**0.56**
29	-8.66	*0.0002*	**1.00**	-9.59	*0.0001*	**0.39**	-9.18	*0.0001*	**0.59**	-9.12	*0.0001*	**0.63**	-9.23	*0.0001*	**0.56**
30	-8.56	*0.0002*	**1.00**	-9.49	*0.0001*	**0.40**	-9.08	*0.0001*	**0.59**	-9.02	*0.0001*	**0.63**	-9.13	*0.0001*	**0.56**
31	-8.46	*0.0002*	**1.00**	-9.39	*0.0001*	**0.40**	-8.98	*0.0001*	**0.60**	-8.92	*0.0001*	**0.63**	-9.03	*0.0001*	**0.57**
32	-8.37	*0.0002*	**1.00**	-9.29	*0.0001*	**0.40**	-8.88	*0.0001*	**0.60**	-8.82	*0.0001*	**0.64**	-8.93	*0.0001*	**0.57**
33	-8.27	*0.0003*	**1.00**	-9.19	*0.0001*	**0.40**	-8.78	*0.0002*	**0.60**	-8.72	*0.0002*	**0.64**	-8.83	*0.0001*	**0.57**
34	-8.17	*0.0003*	**1.00**	-9.08	*0.0001*	**0.40**	-8.68	*0.0002*	**0.60**	-8.62	*0.0002*	**0.64**	-8.73	*0.0002*	**0.57**
35	-8.08	*0.0003*	**1.00**	-8.98	*0.0001*	**0.40**	-8.57	*0.0002*	**0.61**	-8.51	*0.0002*	**0.65**	-8.63	*0.0002*	**0.58**
36	-7.98	*0.0003*	**1.00**	-8.88	*0.0001*	**0.41**	-8.47	*0.0002*	**0.61**	-8.41	*0.0002*	**0.65**	-8.53	*0.0002*	**0.58**
37	-7.88	*0.0004*	**1.00**	-8.78	*0.0002*	**0.41**	-8.37	*0.0002*	**0.61**	-8.31	*0.0002*	**0.65**	-8.42	*0.0002*	**0.58**
38	-7.79	*0.0004*	**1.00**	-8.68	*0.0002*	**0.41**	-8.27	*0.0003*	**0.62**	-8.21	*0.0003*	**0.65**	-8.32	*0.0002*	**0.58**
39	-7.69	*0.0005*	**1.00**	-8.58	*0.0002*	**0.41**	-8.17	*0.0003*	**0.62**	-8.11	*0.0003*	**0.66**	-8.22	*0.0003*	**0.59**
40	-7.59	*0.0005*	**1.00**	-8.48	*0.0002*	**0.41**	-8.07	*0.0003*	**0.62**	-8.01	*0.0003*	**0.66**	-8.12	*0.0003*	**0.59**
41	-7.49	*0.0006*	**1.00**	-8.38	*0.0002*	**0.41**	-7.97	*0.0003*	**0.62**	-7.91	*0.0004*	**0.66**	-8.02	*0.0003*	**0.59**
42	-7.40	*0.0006*	**1.00**	-8.28	*0.0003*	**0.42**	-7.87	*0.0004*	**0.63**	-7.81	*0.0004*	**0.67**	-7.92	*0.0004*	**0.59**
43	-7.30	*0.0007*	**1.00**	-8.17	*0.0003*	**0.42**	-7.77	*0.0004*	**0.63**	-7.70	*0.0005*	**0.67**	-7.82	*0.0004*	**0.60**
44	-7.20	*0.0007*	**1.00**	-8.07	*0.0003*	**0.42**	-7.66	*0.0005*	**0.63**	-7.60	*0.0005*	**0.67**	-7.72	*0.0004*	**0.60**
45	-7.11	*0.0008*	**1.00**	-7.97	*0.0003*	**0.42**	-7.56	*0.0005*	**0.63**	-7.50	*0.0006*	**0.67**	-7.61	*0.0005*	**0.60**
46	-7.01	*0.0009*	**1.00**	-7.87	*0.0004*	**0.42**	-7.46	*0.0006*	**0.64**	-7.40	*0.0006*	**0.68**	-7.51	*0.0005*	**0.60**
47	-6.91	*0.0010*	**1.00**	-7.77	*0.0004*	**0.42**	-7.36	*0.0006*	**0.64**	-7.30	*0.0007*	**0.68**	-7.41	*0.0006*	**0.61**
48	-6.82	*0.0011*	**1.00**	-7.67	*0.0005*	**0.43**	-7.26	*0.0007*	**0.64**	-7.20	*0.0007*	**0.68**	-7.31	*0.0007*	**0.61**
49	-6.72	*0.0012*	**1.00**	-7.57	*0.0005*	**0.43**	-7.16	*0.0008*	**0.64**	-7.10	*0.0008*	**0.69**	-7.21	*0.0007*	**0.61**
50	-6.62	*0.0013*	**1.00**	-7.47	*0.0006*	**0.43**	-7.06	*0.0009*	**0.65**	-7.00	*0.0009*	**0.69**	-7.11	*0.0008*	**0.61**
51	-6.53	*0.0015*	**1.00**	-7.36	*0.0006*	**0.43**	-6.96	*0.0010*	**0.65**	-6.89	*0.0010*	**0.69**	-7.01	*0.0009*	**0.62**
52	-6.43	*0.0016*	**1.00**	-7.26	*0.0007*	**0.43**	-6.85	*0.0011*	**0.65**	-6.79	*0.0011*	**0.69**	-6.91	*0.0010*	**0.62**
53	-6.33	*0.0018*	**1.00**	-7.16	*0.0008*	**0.44**	-6.75	*0.0012*	**0.66**	-6.69	*0.0012*	**0.70**	-6.81	*0.0011*	**0.62**
54	-6.23	*0.0020*	**1.00**	-7.06	*0.0009*	**0.44**	-6.65	*0.0013*	**0.66**	-6.59	*0.0014*	**0.70**	-6.70	*0.0012*	**0.63**
55	-6.14	*0.0022*	**1.00**	-6.96	*0.0009*	**0.44**	-6.55	*0.0014*	**0.66**	-6.49	*0.0015*	**0.70**	-6.60	*0.0014*	**0.63**
56	-6.04	*0.0024*	**1.00**	-6.86	*0.0011*	**0.44**	-6.45	*0.0016*	**0.66**	-6.39	*0.0017*	**0.71**	-6.50	*0.0015*	**0.63**
57	-5.94	*0.0026*	**1.00**	-6.76	*0.0012*	**0.44**	-6.35	*0.0017*	**0.67**	-6.29	*0.0019*	**0.71**	-6.40	*0.0017*	**0.63**
58	-5.85	*0.0029*	**1.00**	-6.66	*0.0013*	**0.45**	-6.25	*0.0019*	**0.67**	-6.19	*0.0021*	**0.71**	-6.30	*0.0018*	**0.64**
59	-5.75	*0.0032*	**1.00**	-6.55	*0.0014*	**0.45**	-6.15	*0.0021*	**0.67**	-6.09	*0.0023*	**0.72**	-6.20	*0.0020*	**0.64**
60	-5.65	*0.0035*	**1.00**	-6.45	*0.0016*	**0.45**	-6.04	*0.0024*	**0.68**	-5.98	*0.0025*	**0.72**	-6.10	*0.0023*	**0.64**
61	-5.56	*0.0039*	**1.00**	-6.35	*0.0017*	**0.45**	-5.94	*0.0026*	**0.68**	-5.88	*0.0028*	**0.72**	-6.00	*0.0025*	**0.64**
62	-5.46	*0.0043*	**1.00**	-6.25	*0.0019*	**0.45**	-5.84	*0.0029*	**0.68**	-5.78	*0.0031*	**0.72**	-5.89	*0.0028*	**0.65**
63	-5.36	*0.0047*	**1.00**	-6.15	*0.0021*	**0.45**	-5.74	*0.0032*	**0.68**	-5.68	*0.0034*	**0.73**	-5.79	*0.0030*	**0.65**
64	-5.27	*0.0052*	**1.00**	-6.05	*0.0024*	**0.46**	-5.64	*0.0036*	**0.69**	-5.58	*0.0038*	**0.73**	-5.69	*0.0034*	**0.65**
65	-5.17	*0.0057*	**1.00**	-5.95	*0.0026*	**0.46**	-5.54	*0.0039*	**0.69**	-5.48	*0.0042*	**0.73**	-5.59	*0.0037*	**0.66**
66	-5.07	*0.0063*	**1.00**	-5.85	*0.0029*	**0.46**	-5.44	*0.0044*	**0.69**	-5.38	*0.0046*	**0.74**	-5.49	*0.0041*	**0.66**
67	-4.97	*0.0069*	**1.00**	-5.75	*0.0032*	**0.46**	-5.34	*0.0048*	**0.70**	-5.28	*0.0051*	**0.74**	-5.39	*0.0046*	**0.66**
68	-4.88	*0.0076*	**1.00**	-5.64	*0.0035*	**0.46**	-5.24	*0.0053*	**0.70**	-5.17	*0.0057*	**0.74**	-5.29	*0.0051*	**0.66**
69	-4.78	*0.0084*	**1.00**	-5.54	*0.0039*	**0.47**	-5.13	*0.0059*	**0.70**	-5.07	*0.0063*	**0.75**	-5.19	*0.0056*	**0.67**
70	-4.68	*0.0092*	**1.00**	-5.44	*0.0043*	**0.47**	-5.03	*0.0065*	**0.71**	-4.97	*0.0069*	**0.75**	-5.08	*0.0062*	**0.67**
71	-4.59	*0.0102*	**1.00**	-5.34	*0.0048*	**0.47**	-4.93	*0.0072*	**0.71**	-4.87	*0.0077*	**0.75**	-4.98	*0.0069*	**0.67**
72	-4.49	*0.0112*	**1.00**	-5.24	*0.0053*	**0.47**	-4.83	*0.0080*	**0.71**	-4.77	*0.0085*	**0.76**	-4.88	*0.0076*	**0.68**
73	-4.39	*0.0124*	**1.00**	-5.14	*0.0059*	**0.47**	-4.73	*0.0088*	**0.71**	-4.67	*0.0094*	**0.76**	-4.78	*0.0084*	**0.68**
74	-4.30	*0.0136*	**1.00**	-5.04	*0.0065*	**0.48**	-4.63	*0.0098*	**0.72**	-4.57	*0.0104*	**0.76**	-4.68	*0.0093*	**0.68**
75	-4.20	*0.0150*	**1.00**	-4.94	*0.0072*	**0.48**	-4.53	*0.0108*	**0.72**	-4.47	*0.0115*	**0.77**	-4.58	*0.0103*	**0.68**
76	-4.10	*0.0165*	**1.00**	-4.83	*0.0079*	**0.48**	-4.43	*0.0120*	**0.72**	-4.36	*0.0127*	**0.77**	-4.48	*0.0114*	**0.69**
77	-4.01	*0.0182*	**1.00**	-4.73	*0.0088*	**0.48**	-4.32	*0.0132*	**0.73**	-4.26	*0.0141*	**0.77**	-4.38	*0.0126*	**0.69**
78	-3.91	*0.0201*	**1.00**	-4.63	*0.0097*	**0.48**	-4.22	*0.0147*	**0.73**	-4.16	*0.0156*	**0.78**	-4.28	*0.0139*	**0.69**
79	-3.81	*0.0221*	**1.00**	-4.53	*0.0108*	**0.49**	-4.12	*0.0162*	**0.73**	-4.06	*0.0172*	**0.78**	-4.17	*0.0154*	**0.70**
80	-3.71	*0.0244*	**1.00**	-4.43	*0.0119*	**0.49**	-4.02	*0.0179*	**0.74**	-3.96	*0.0191*	**0.78**	-4.07	*0.0170*	**0.70**

Source: author's calculations based on ONS LS

Table D11. Total number of deaths per cause per year for full ONS LS sample.

Year	CVD	Cancer	Resp	Infectious	Other	Total
1971	2,257	1,155	708	111	1,417	4,231
1972	2,499	1,280	873	132	1,577	4,784
1973	2,369	1,322	748	112	1,540	4,551
1974	2,452	1,279	781	123	1,531	4,635
1975	2,543	1,251	870	143	1,477	4,807
1976	2,413	1,272	813	122	1,486	4,620
1977	2,500	1,292	884	110	1,534	4,786
1978	2,750	1,328	808	104	1,080	4,990
1979	3,078	1,370	845	126	668	5,419
1980	3,035	1,404	881	119	650	5,439
1981	3,464	1,482	689	172	941	5,807
1982	3,307	1,501	659	148	859	5,615
1983	3,191	1,540	651	162	919	5,544
1984	3,219	1,485	685	159	887	5,548
1985	3,204	1,582	723	157	919	5,666
1986	3,072	1,589	636	156	952	5,453
1987	3,083	1,551	627	154	897	5,415
1988	3,013	1,500	632	147	925	5,292
1989	3,138	1,661	775	146	923	5,720
1990	3,004	1,650	692	146	968	5,492
1991	2,943	1,737	679	159	982	5,518
1992	3,061	1,693	735	158	875	5,647
1993	3,035	1,549	1034	163	945	5,781
1994	2,890	1,667	930	174	912	5,661
1995	2,774	1,618	1099	192	992	5,683
1996	2,771	1,565	1105	172	954	5,613
1997	2,595	1,631	948	183	1,013	5,357
1998	2,729	1,543	1098	171	1,004	5,541
1999	2,526	1,556	1140	189	1,060	5,411
2000	2,395	1,580	913	170	1,083	5,058
2001	2,543	1,663	901	185	1,248	5,292
2002	2,650	1,679	858	189	1,181	5,376
2003	2,493	1,710	911	185	1,196	5,299
2004	2,368	1,721	898	175	1,232	5,162
2005	2,177	1,641	856	201	1,217	4,875
2006	2,149	1,625	839	188	1,256	4,801
2007	2,144	1,685	741	186	1,265	4,756
2008	2,089	1,588	841	177	1,323	4,695
2009	1,939	1,651	790	200	1,216	4,580
2010	1,892	1,704	816	183	1,293	4,595
2011	1,703	1,728	860	165	1,400	4,456
Total	**109,457**	**63,028**	**33,972**	**6,514**	**45,797**	**258,768**

Source: author's calculations based on ONS LS

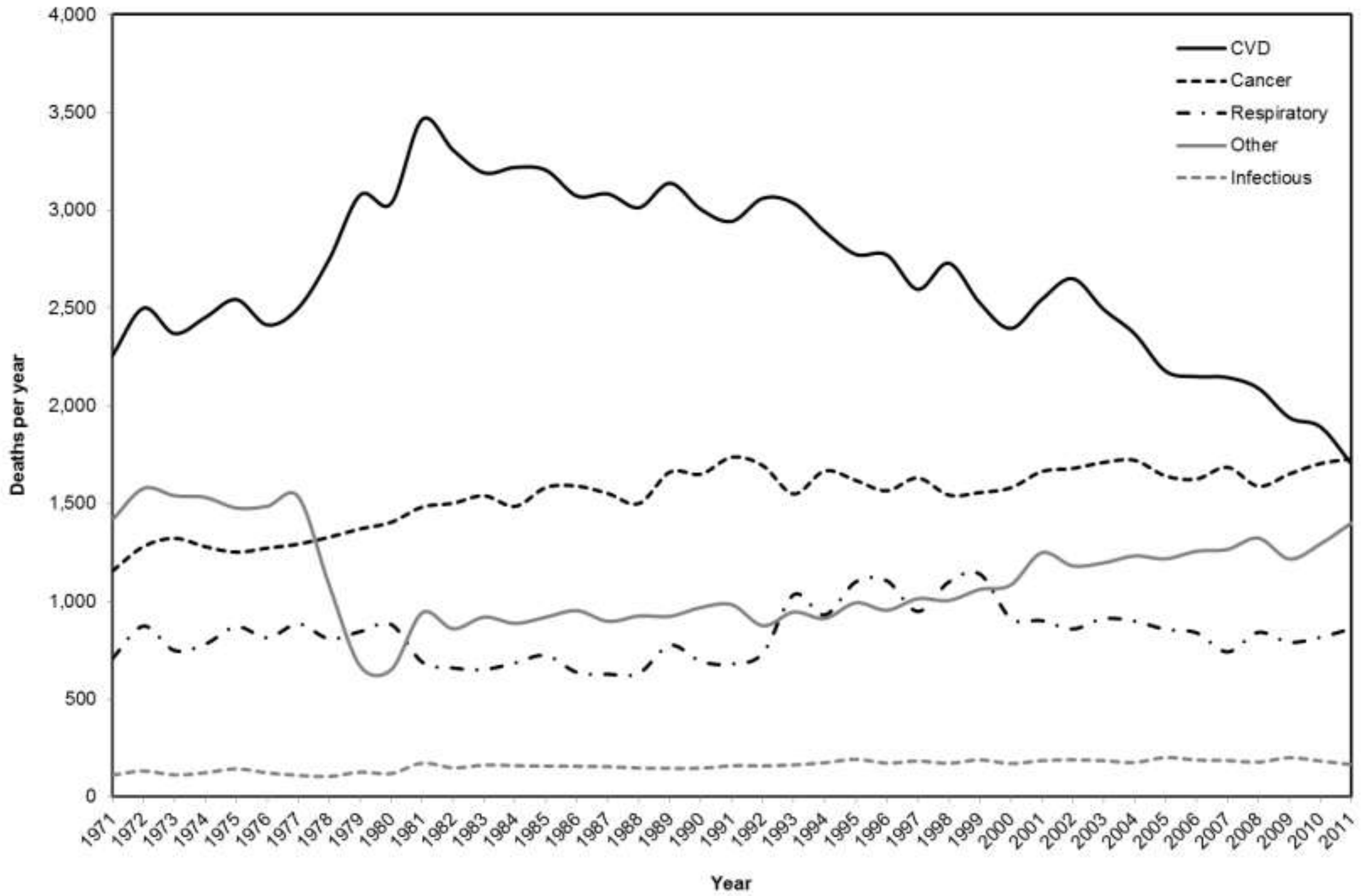

Figure D1. Plot of Table D11: Total number of deaths per cause per year for full ONS LS sample.

Source: author's calculations based on ONS LS

Table D12. Cardiovascular disease: separate analysis of cause of death (male).[55]

Cardiovascular	Male									
	Basic					SES				
	Log Haz	Std Error	Z-score	P-value	Haz Ratio	Log Haz	Std Error	Z-score	P-value	Haz Ratio
Period										
1971-1981	**0**				**1**	**0**				**1**
1981-1991	-0.11	0.04	-2.48	*0.01*	0.89	-0.12	0.04	-2.63	*0.01*	0.89
1991-2001	-0.44	0.03	-9.86	*0.00*	0.64	-0.52	0.03	-11.50	*0.00*	0.59
2001-2012	-1.00	0.02	-21.05	*0.00*	0.37	-1.05	0.02	-21.87	*0.00*	0.35
Country of birth										
England and Wales	**0**				**1**	**0**				**1**
Scotland	0.21	0.07	3.74	*0.00*	1.23	0.21	0.07	3.81	*0.00*	1.24
Northern Ireland	0.18	0.12	1.74	*0.08*	1.20	0.08	0.11	0.73	*0.47*	1.08
Republic of Ireland	0.24	0.07	4.15	*0.00*	1.27	0.00	0.06	0.00	*1.00*	1.00
India	0.26	0.07	5.17	*0.00*	1.30	0.20	0.06	3.89	*0.00*	1.23
Pakistan	0.13	0.09	1.51	*0.13*	1.13	-0.03	0.08	-0.31	*0.76*	0.97
Bangladesh	0.43	0.17	3.84	*0.00*	1.54	0.24	0.14	2.08	*0.04*	1.27
Jamaica	0.05	0.10	0.54	*0.59*	1.05	-0.31	0.07	-3.16	*0.00*	0.73
Other Caribbean	0.04	0.13	0.31	*0.76*	1.04	-0.18	0.10	-1.46	*0.14*	0.83
East and Southern Africa	-0.15	0.11	-1.14	*0.25*	0.86	-0.18	0.11	-1.42	*0.16*	0.83
West and Central Africa	0.42	0.21	3.05	*0.00*	1.52	0.22	0.17	1.59	*0.11*	1.25
Western Europe	-0.16	0.07	-1.92	*0.06*	0.85	-0.21	0.07	-2.51	*0.01*	0.81
Eastern Europe	0.11	0.10	1.17	*0.24*	1.11	-0.08	0.09	-0.83	*0.41*	0.93
China	-0.08	0.16	-0.46	*0.65*	0.92	-0.11	0.16	-0.61	*0.54*	0.90
Other Asia	-0.42	0.12	-2.39	*0.02*	0.66	-0.42	0.12	-2.39	*0.02*	0.65
Rest of the World	-0.26	0.07	-2.79	*0.01*	0.77	-0.28	0.07	-2.98	*0.00*	0.76
Occupation Type										
Professional/Managerial						**0**				**1**
Skilled						0.20	0.03	8.04	*0.00*	1.22
Unskilled						0.37	0.04	12.80	*0.00*	1.44
Missing						0.76	0.07	23.88	*0.00*	2.14
Education Level										
Degree level						-0.40	0.02	-10.86	*0.00*	0.67
A-level						-0.16	0.04	-3.45	*0.00*	0.85
No 18+ qualificatons						**0**				**1**
Missing						1.28	0.20	22.73	*0.00*	3.61
Marital Status	*(Not adjusted for socioeconomic characteristics)*									
Married						**0**				**1**
Single						0.45	0.04	16.85	*0.00*	1.57
Divorced						0.42	0.05	14.35	*0.00*	1.53
Widowed						0.21	0.05	5.47	*0.00*	1.23
Missing						*(omitted)*				
Area of Residence Type										
Rural						**0**				**1**
London						0.05	0.03	1.69	*0.09*	1.05
Other Urban						0.18	0.03	8.41	*0.00*	1.19
Missing						*(omitted)*				

Source: author's calculations based on ONS LS

[55] Basic (constant) **0.0000006220**; (SE) **0.00000003420**; (z-score) **-260.09**; (p-value) **0.00**; Basic (gamma) **0.0095221**; (SE) **0.0000753**; (z-score) **-260.09**; (p-value) **0.00; SES** (constant) **0.000000416**; (SE) **0.0000000253**; (z-score) **-242.07**; (p-value) **0.00**; SES (gamma) **0.0006446**; (SE) **0.0000767**; (z-score) **125.79**; (p-value) **0.00**

Table D13. Cardiovascular disease: separate analysis of cause of death (female).[56]

Cardiovascular	Female									
	Basic					SES				
	Log Haz	Std Error	Z-score	P-value	Haz Ratio	Log Haz	Std Error	Z-score	P-value	Haz Ratio
Period										
1971-1981	**0**				**1**	**0**				**1**
1981-1991	-0.13	0.07	-1.55	*0.12*	0.88	-0.02	0.08	-0.25	*0.81*	0.98
1991-2001	-0.37	0.05	-4.72	*0.00*	0.69	-0.22	0.06	-2.71	*0.01*	0.81
2001-2012	-0.78	0.04	-9.47	*0.00*	0.46	-0.42	0.05	-5.07	*0.00*	0.65
Country of birth										
England and Wales	**0**				**1**	**0**				**1**
Scotland	0.30	0.11	3.81	*0.00*	1.36	0.29	0.11	3.63	*0.00*	1.34
Northern Ireland	0.24	0.17	1.72	*0.09*	1.27	0.17	0.16	1.21	*0.23*	1.18
Republic of Ireland	0.24	0.10	3.13	*0.00*	1.27	0.10	0.08	1.32	*0.19*	1.11
India	0.32	0.11	4.06	*0.00*	1.38	0.08	0.09	0.95	*0.34*	1.08
Pakistan	0.49	0.20	3.97	*0.00*	1.64	-0.02	0.12	-0.14	*0.89*	0.98
Bangladesh	0.08	0.27	0.33	*0.75*	1.09	-0.50	0.15	-1.99	*0.05*	0.61
Jamaica	0.48	0.18	4.24	*0.00*	1.61	0.21	0.14	1.86	*0.06*	1.24
Other Caribbean	0.00	0.19	0.01	*1.00*	1.00	-0.17	0.16	-0.92	*0.36*	0.84
East and Southern Africa	-0.05	0.17	-0.28	*0.78*	0.95	-0.26	0.14	-1.43	*0.15*	0.77
West and Central Africa	0.05	0.29	0.19	*0.85*	1.05	-0.10	0.25	-0.35	*0.72*	0.91
Western Europe	-0.14	0.08	-1.59	*0.11*	0.87	-0.23	0.07	-2.60	*0.01*	0.79
Eastern Europe	0.10	0.14	0.80	*0.42*	1.11	-0.01	0.13	-0.08	*0.93*	0.99
China	-0.10	0.29	-0.33	*0.74*	0.90	-0.31	0.23	-0.99	*0.32*	0.73
Other Asia	-0.29	0.16	-1.41	*0.16*	0.74	-0.43	0.14	-2.05	*0.04*	0.65
Rest of the World	-0.21	0.10	-1.78	*0.08*	0.81	-0.26	0.09	-2.23	*0.03*	0.77
Occupation Type										
Professional/Managerial						**0**				**1**
Skilled						0.06	0.05	1.19	*0.23*	1.06
Unskilled						0.42	0.07	8.87	*0.00*	1.53
Missing						0.88	0.11	19.58	*0.00*	2.42
Education Level										
Degree level						-0.43	0.04	-7.30	*0.00*	0.65
A-level						0.00	0.05	-4.80	*0.00*	0.68
No 18+ qualificatons						**0**				**1**
Missing	*(Not adjusted for socioeconomic characteristics)*					1.41	0.30	19.54	*0.00*	4.10
Marital Status										
Married						**0**				**1**
Single						0.65	0.08	14.81	*0.00*	1.92
Divorced						0.31	0.06	7.52	*0.00*	1.37
Widowed						0.21	0.04	6.58	*0.00*	1.23
Missing						*(omitted)*				
Area of Residence Type										
Rural						**0**				**1**
London						-0.03	0.04	-0.82	*0.41*	0.97
Other Urban						0.18	0.03	6.15	*0.00*	1.20
Missing						*(omitted)*				

Source: author's calculations based on ONS LS

[56] Basic (constant) **0.0000001030**; (SE) **0.000000009500**; (z-score) **-174.13**; (p-value) **0.00**; Basic (gamma) **0.0106648**; (SE) **0.0001124**; (z-score) **-162.27**; (p-value) **0.00; SES** (constant) **0.00000007220**; (SE) **0.000000007320**; (z-score) **-162.27**; (p-value) **0.00**; SES (gamma) **0.0101268**; (SE) **0.000115**; (z-score) **88.02**; (p-value) **0.00**

Table D14. Respiratory diseases: separate analysis of cause of death (male).[57]

Respiratory	Male									
	Basic					SES				
	Log Haz	Std Error	Z-score	P-value	Haz Ratio	Log Haz	Std Error	Z-score	P-value	Haz Ratio
Period										
1971-1981	**0**				**1**	**0**				**1**
1981-1991	-0.34	0.09	-2.66	*0.01*	0.71	-0.33	0.09	-2.64	*0.01*	0.72
1991-2001	-0.23	0.09	-2.00	*0.05*	0.79	-0.33	0.08	-2.81	*0.01*	0.72
2001-2012	-0.47	0.08	-3.91	*0.00*	0.62	-0.52	0.07	-4.25	*0.00*	0.59
Country of birth										
England and Wales	**0**				**1**	**0**				**1**
Scotland	0.32	0.14	3.01	*0.00*	1.37	0.33	0.15	3.13	*0.00*	1.39
Northern Ireland	0.45	0.28	2.55	*0.01*	1.57	0.28	0.23	1.55	*0.12*	1.32
Irish Republic	0.44	0.16	4.30	*0.00*	1.56	0.03	0.11	0.31	*0.75*	1.03
South Asian	-0.33	0.08	-3.10	*0.00*	0.72	-0.51	0.07	-4.67	*0.00*	0.60
Caribbean	-0.57	0.12	-2.79	*0.01*	0.56	-1.10	0.07	-5.34	*0.00*	0.33
African	-0.63	0.14	-2.36	*0.02*	0.53	-0.83	0.12	-3.09	*0.00*	0.43
European	-0.78	0.08	-4.48	*0.00*	0.46	-0.97	0.07	-5.53	*0.00*	0.38
Chinese	-0.44	0.17	-1.62	*0.10*	0.65	-0.47	0.17	-1.77	*0.08*	0.62
Rest of the World	-0.01	0.16	-0.08	*0.94*	0.99	-0.07	0.15	-0.40	*0.69*	0.94
Occupation Type										
Professional/Managerial						**0**				**1**
Skilled						0.45	0.09	7.89	*0.00*	1.57
Unskilled						0.78	0.13	12.64	*0.00*	2.17
Missing						1.38	0.25	22.07	*0.00*	3.99
Education Level										
Degree level						-0.61	0.04	-7.38	*0.00*	0.54
A-level						0.00	0.08	-3.14	*0.00*	0.71
No 18+ qualificatons						**0**				**1**
Missing						1.32	0.37	13.17	*0.00*	3.74
Marital Status	*(Not adjusted for socioeconomic characteristics)*									
Married						**0**				**1**
Single						0.82	0.11	16.55	*0.00*	2.27
Divorced						0.61	0.10	10.79	*0.00*	1.83
Widowed						0.47	0.10	7.41	*0.00*	1.60
Missing						*(omitted)*				
Area of Residence Type										
Rural						**0**				**1**
London						0.18	0.07	3.09	*0.00*	1.19
Other Urban						0.24	0.05	5.83	*0.00*	1.28
Missing						*(omitted)*				

Source: author's calculations based on ONS LS

[57] Basic (constant) **0.00000004510**; (SE) **0.000000006130**; (z-score) **-124.44**; (p-value) **0.00**; Basic (gamma) **0.0107051**; (SE) **0.0001596**; (z-score) **67.09**; (p-value) **0.00; SES** (constant) **0.0000000213**; (SE) **0.00000000311**; (z-score) **-120.97**; (p-value) **0.00**; SES (gamma) **0.0107362**; (SE) **0.0001593**; (z-score) **67.42**; (p-value) **0.00**

Table D15. Respiratory diseases: separate analysis of cause of death (female).[58]

Respiratory	Female									
	Basic					SES				
	Log Haz	Std Error	Z-score	P-value	Haz Ratio	Log Haz	Std Error	Z-score	P-value	Haz Ratio
Period										
1971-1981	**0**				**1**	**0**				**1**
1981-1991	-0.62	0.07	-4.46	*0.00*	0.54	-0.52	0.08	-3.72	*0.00*	0.60
1991-2001	-0.51	0.08	-4.04	*0.00*	0.60	-0.37	0.09	-2.91	*0.00*	0.69
2001-2012	-0.70	0.06	-5.37	*0.00*	0.50	-0.36	0.09	-2.75	*0.01*	0.69
Country of birth										
England and Wales	**0**				**1**	**0**				**1**
Scotland	0.54	0.20	4.69	*0.00*	1.72	0.51	0.19	4.38	*0.00*	1.66
Northern Ireland	0.32	0.29	1.48	*0.14*	1.37	0.21	0.26	0.98	*0.33*	1.23
Irish Republic	0.31	0.16	2.62	*0.01*	1.36	0.12	0.14	1.02	*0.31*	1.13
South Asian	-0.10	0.12	-0.74	*0.46*	0.91	-0.49	0.08	-3.69	*0.00*	0.62
Caribbean	-0.22	0.16	-1.09	*0.27*	0.80	-0.56	0.12	-2.70	*0.01*	0.57
African	-0.27	0.21	-1.00	*0.32*	0.77	-0.50	0.16	-1.86	*0.06*	0.60
European	-0.57	0.09	-3.75	*0.00*	0.56	-0.71	0.08	-4.61	*0.00*	0.49
Chinese	-0.86	0.16	-2.27	*0.02*	0.42	-1.04	0.13	-2.74	*0.01*	0.35
Rest of the World	-0.17	0.16	-0.91	*0.36*	0.85	-0.24	0.15	-1.31	*0.19*	0.78
Occupation Type										
Professional/Managerial						**0**				**1**
Skilled						0.10	0.09	1.28	*0.20*	1.11
Unskilled						0.57	0.14	7.15	*0.00*	1.76
Missing						1.00	0.21	13.26	*0.00*	2.73
Education Level										
Degree level						0.00	0.06	-4.79	*0.00*	0.63
A-level						-0.45	0.09	-3.22	*0.00*	0.64
No 18+ qualificatons						**0**				**1**
Missing						1.74	0.62	16.06	*0.00*	5.72
Marital Status	*(Not adjusted for socioeconomic characteristics)*									
Married						**0**				**1**
Single						0.74	0.15	10.28	*0.00*	2.10
Divorced						0.60	0.11	9.59	*0.00*	1.83
Widowed						0.32	0.07	6.09	*0.00*	1.37
Missing						*(omitted)*				
Area of Residence Type										
Rural						**0**				**1**
London						-0.01	0.07	-0.12	*0.91*	0.99
Other Urban						0.27	0.06	5.74	*0.00*	1.31
Missing						*(omitted)*				

Source: author's calculations based on ONS LS

[58] Basic (constant) **0.00000004700**; (SE) **0.000000006870**; (z-score) **-115.37**; (p-value) **0.00**; Basic (gamma) **0.0104725**; (SE) **0.0001802**; (z-score) **58.12**; (p-value) **0.00;** SES (constant) **0.00000002890**; (SE) **0.000000004680**; (z-score) **-106.96;** (p-value) **0.00**; SES (gamma) **0.0098919**; (SE) **0.0001849**; (z-score) **53.49**; (p-value) **0.00**

Table D16. Cancers: separate analysis of cause of death (male).[59]

Cancer	Male									
	Basic					SES				
	Log Haz	Std Error	Z-score	P-value	Haz Ratio	Log Haz	Std Error	Z-score	P-value	Haz Ratio
Period										
1971-1981	**0**				**1**	**0**				**1**
1981-1991	0.06	0.06	1.12	*0.26*	1.06	0.07	0.06	1.21	*0.23*	1.07
1991-2001	0.02	0.05	0.30	*0.76*	1.02	-0.02	0.05	-0.30	*0.76*	0.98
2001-2012	-0.21	0.04	-3.78	*0.00*	0.81	-0.20	0.05	-3.56	*0.00*	0.82
Country of birth										
England and Wales	**0**				**1**	**0**				**1**
Scotland	0.23	0.07	4.05	*0.00*	1.26	0.21	0.07	3.69	*0.00*	1.23
Northern Ireland	0.36	0.14	3.72	*0.00*	1.43	0.28	0.13	2.84	*0.00*	1.32
Republic of Ireland	0.28	0.08	4.75	*0.00*	1.32	0.07	0.06	1.13	*0.26*	1.07
India	-0.82	0.04	-9.28	*0.00*	0.44	-0.91	0.04	-10.22	*0.00*	0.40
Pakistan	-0.62	0.06	-5.15	*0.00*	0.54	-0.77	0.06	-6.42	*0.00*	0.46
Bangladesh	-0.60	0.10	-3.18	*0.00*	0.55	-0.80	0.09	-4.21	*0.00*	0.45
Jamaica	-0.02	0.10	-0.21	*0.84*	0.98	-0.33	0.08	-3.06	*0.00*	0.72
Other Caribbean	-0.20	0.12	-1.38	*0.17*	0.82	-0.38	0.10	-2.70	*0.01*	0.68
East and Southern Africa	-0.54	0.09	-3.54	*0.00*	0.58	-0.60	0.08	-3.93	*0.00*	0.55
West and Central Africa	-0.21	0.15	-1.12	*0.26*	0.81	-0.42	0.12	-2.23	*0.03*	0.66
Western Europe	-0.25	0.07	-2.82	*0.01*	0.78	-0.34	0.06	-3.80	*0.00*	0.71
Eastern Europe	-0.13	0.10	-1.18	*0.24*	0.88	-0.30	0.08	-2.72	*0.01*	0.74
China	-0.13	0.16	-0.69	*0.49*	0.88	-0.19	0.15	-1.05	*0.29*	0.82
Other Asia	-0.42	0.11	-2.43	*0.02*	0.65	-0.45	0.11	-2.56	*0.01*	0.64
Rest of the World	-0.24	0.07	-2.65	*0.01*	0.78	-0.28	0.07	-3.06	*0.00*	0.75
Occupation Type										
Professional/Managerial						**0**				**1**
Skilled						0.13	0.03	5.08	*0.00*	1.14
Unskilled						0.26	0.04	8.89	*0.00*	1.29
Missing						0.46	0.06	13.06	*0.00*	1.58
Education Level										
Degree level						-0.33	0.03	-9.33	*0.00*	0.72
A-level						0.00	0.04	-4.27	*0.00*	0.82
No 18+ qualificatons						**0**				**1**
Missing			*(Not adjusted for*			1.53	0.27	26.27	*0.00*	4.63
Marital Status			*socioeconomic characteristics)*							
Married						**0**				**1**
Single						0.10	0.03	3.15	*0.00*	1.10
Divorced						0.18	0.04	5.54	*0.00*	1.19
Widowed						0.03	0.04	0.61	*0.54*	1.03
Missing						*(omitted)*				
Type of Area										
Rural						**0**				**1**
London						0.10	0.03	3.38	*0.00*	1.11
Other Urban						0.12	0.03	5.43	*0.00*	1.13
Missing						*(omitted)*				

Source: author's calculations based on ONS LS

[59] Basic (constant) **0.0000006310**; (SE) **0.00000003850**; (z-score) **-234.05**; (p-value) **0.00**; Basic (gamma) **0.0086853**; (SE) **0.0000729**; (z-score) **-234.05**; (p-value) **0.00; SES** (constant) **0.000000548**; (SE) **0.0000000366**; (z-score) **-215.98**; (p-value) **0.00**; SES (gamma) **0.0086341**; (SE) **0.0000761**; (z-score) **113.47**; (p-value) **0.00**

Table D17. Cancers: separate analysis of cause of death (female).[60]

Cancer	Female									
	Basic					SES				
	Log Haz	Std Error	Z-score	P-value	Haz Ratio	Log Haz	Std Error	Z-score	P-value	Haz Ratio
Period										
1971-1981	**0**				**1**	**0**				**1**
1981-1991	0.06	0.06	1.09	*0.28*	1.06	0.09	0.06	1.74	*0.08*	1.10
1991-2001	-0.07	0.05	-1.32	*0.19*	0.94	-0.03	0.05	-0.53	*0.60*	0.97
2001-2012	-0.24	0.04	-4.64	*0.00*	0.79	-0.12	0.05	-2.15	*0.03*	0.89
Country of birth										
England and Wales	**0**				**1**	**0**				**1**
Scotland	0.23	0.08	3.66	*0.00*	1.26	0.21	0.08	3.31	*0.00*	1.24
Northern Ireland	-0.02	0.12	-0.16	*0.87*	0.98	-0.08	0.11	-0.64	*0.52*	0.92
Republic of Ireland	0.20	0.08	3.18	*0.00*	1.22	0.09	0.07	1.38	*0.17*	1.09
India	-0.59	0.05	-6.37	*0.00*	0.55	-0.74	0.04	-7.90	*0.00*	0.47
Pakistan	-0.48	0.09	-3.34	*0.00*	0.62	-0.74	0.07	-5.10	*0.00*	0.48
Bangladesh	-0.90	0.11	-3.24	*0.00*	0.41	-1.23	0.08	-4.42	*0.00*	0.29
Jamaica	0.06	0.12	0.55	*0.58*	1.06	-0.16	0.09	-1.49	*0.14*	0.85
Other Caribbean	-0.34	0.12	-2.03	*0.04*	0.71	-0.50	0.10	-2.96	*0.00*	0.60
East and Southern Africa	-0.47	0.10	-3.07	*0.00*	0.63	-0.60	0.08	-3.92	*0.00*	0.55
West and Central Africa	-0.75	0.13	-2.71	*0.01*	0.47	-0.97	0.11	-3.48	*0.00*	0.38
Western Europe	-0.27	0.06	-3.49	*0.00*	0.77	-0.37	0.05	-4.80	*0.00*	0.69
Eastern Europe	-0.33	0.09	-2.54	*0.01*	0.72	-0.41	0.09	-3.22	*0.00*	0.66
China	-0.50	0.17	-1.79	*0.07*	0.61	-0.64	0.15	-2.30	*0.02*	0.53
Other Asia	-0.55	0.10	-3.24	*0.00*	0.58	-0.64	0.09	-3.77	*0.00*	0.53
Rest of the World	-0.35	0.07	-3.70	*0.00*	0.71	-0.41	0.06	-4.31	*0.00*	0.67
Occupation Type										
Professional/Managerial						**0**				**1**
Skilled						0.00	0.03	0.15	*0.88*	1.00
Unskilled						0.19	0.04	5.64	*0.00*	1.21
Missing						0.28	0.04	8.27	*0.00*	1.32
Education Level										
Degree level						0.00	0.03	-6.24	*0.00*	0.77
A-level						-0.10	0.05	-1.99	*0.05*	0.91
No 18+ qualificatons						**0**				**1**
Missing						1.78	0.36	29.46	*0.00*	5.92
Marital Status	*(Not adjusted for socioeconomic characteristics)*									
Married						**0**				**1**
Single						0.06	0.04	1.71	*0.09*	1.07
Divorced						0.18	0.04	5.60	*0.00*	1.20
Widowed						0.00	0.03	0.06	*0.95*	1.00
Missing						*(omitted)*				
Type of Area										
Rural						**0**				**1**
London						0.09	0.04	2.89	*0.00*	1.10
Other Urban						0.09	0.03	3.94	*0.00*	1.10
Missing						*(omitted)*				

Source: author's calculations based on ONS LS

[60] Basic (constant) **0.000001420**; (SE) **0.00000008130**; (z-score) **-235.21**; (p-value) **0.00**; Basic (gamma) **0.0074053**; (SE) **0.0000713**; (z-score) **103.87**; (p-value) **0.00; SES** (constant) **0.000001250**; (SE) **0.00000008130**; (z-score) **-235.21**; (p-value) **0.00**; SES (gamma) **0.0072481**; (SE) **0.0000773**; (z-score) **93.79**; (p-value) **0.00**

Table D18. Infectious diseases: separate analysis of cause of death (male).[61]

Infectious	**Male**									
	Basic					SES				
	Log Haz	Std Error	Z-score	P-value	Haz Ratio	Log Haz	Std Error	Z-score	P-value	Haz Ratio
Period										
1971-1981	**0**				**1**	**0**				**1**
1981-1991	0.03	0.32	0.11	*0.91*	1.03	0.30	0.30	-0.17	*0.86*	0.95
1991-2001	0.49	0.46	1.72	*0.09*	1.63	0.38	0.38	0.97	*0.33*	1.32
2001-2012	0.59	0.51	2.07	*0.04*	1.80	0.43	0.43	1.38	*0.17*	1.49
Country of birth										
England and Wales	**0**				**1**	**0**				**1**
Scotland	0.94	0.66	3.67	*0.00*	2.57	0.67	0.67	3.67	*0.00*	2.59
Northern Ireland	-0.58	0.56	-0.58	*0.57*	0.56	0.50	0.50	-0.69	*0.49*	0.50
Irish Republic	-0.21	0.41	-0.42	*0.67*	0.81	0.28	0.28	-1.15	*0.25*	0.56
South Asian	0.93	0.48	4.91	*0.00*	2.55	0.51	0.51	4.66	*0.00*	2.55
Caribbean	1.10	0.97	3.39	*0.00*	2.99	0.60	0.60	1.78	*0.08*	1.80
African	1.15	0.98	3.73	*0.00*	3.17	0.88	0.88	3.20	*0.00*	2.77
European	-0.01	0.41	-0.02	*0.98*	0.99	0.35	0.35	-0.45	*0.65*	0.83
Chinese	-0.89	0.41	-0.88	*0.38*	0.41	0.41	0.41	-0.89	*0.37*	0.41
Rest of the World	0.58	0.64	1.60	*0.11*	1.78	0.58	0.58	1.29	*0.20*	1.60
Occupation Type										
Professional/Managerial						**0**				**1**
Skilled						0.13	0.13	-1.16	*0.25*	0.84
Unskilled						0.15	0.15	-0.82	*0.41*	0.87
Missing						0.28	0.28	2.41	*0.02*	1.54
Education Level										
Degree level						0.09	0.09	-4.29	*0.00*	0.36
A-level						0.12	0.12	-2.99	*0.00*	0.31
No 18+ qualificatons						**0**				**1**
Missing	*(Not adjusted for socioeconomic characteristics)*					2.08	2.08	7.05	*0.00*	7.36
Marital Status										
Married						**0**				**1**
Single						0.48	0.48	8.31	*0.00*	3.31
Divorced						0.39	0.39	4.82	*0.00*	2.29
Widowed						0.48	0.48	2.68	*0.01*	1.94
Missing						*(omitted)*				
Area of Residence Type										
Rural						**0**				**1**
London						0.23	0.23	2.78	*0.01*	1.52
Other Urban						0.15	0.15	0.70	*0.48*	1.10
Missing						*(omitted)*				

Source: author's calculations based on ONS LS

[61] Basic (constant) **0.0000001050**; (SE) **0.00000003230**; (z-score) **-52.29**; (p-value) **0.00**; Basic (gamma) **0.0052692**; (SE) **0.0003446**; (z-score) **15.29**; (p-value) **0.00;** SES (constant) **0.0000000493**; (SE) **0.0000000172**; (z-score) **-48.08**; (p-value) **0.00**; SES (gamma) **0.0061538**; (SE) **0.0003584**; (z-score) **17.17**; (p-value) **0.00**

Table D19. Infectious diseases: separate analysis of cause of death (female).[62]

Infectious	Female									
	Basic					SES				
	Log Haz	Std Error	Z-score	P-value	Haz Ratio	Log Haz	Std Error	Z-score	P-value	Haz Ratio
Period										
1971-1981	**0**				**1**	**0**				**1**
1981-1991	-0.04	0.36	-0.10	*0.92*	0.96	0.03	0.39	0.07	*0.95*	1.03
1991-2001	-0.04	0.34	-0.10	*0.92*	0.97	0.04	0.37	0.13	*0.90*	1.05
2001-2012	0.04	0.37	0.11	*0.91*	1.04	0.22	0.45	0.61	*0.54*	1.25
Country of birth										
England and Wales	**0**				**1**	**0**				**1**
Scotland	0.72	0.70	2.10	*0.04*	2.05	0.72	0.70	2.11	*0.04*	2.06
Northern Ireland	0.70	1.17	1.20	*0.23*	2.00	0.66	1.13	1.14	*0.26*	1.94
Irish Republic	0.36	0.55	0.93	*0.36*	1.43	0.19	0.47	0.49	*0.62*	1.21
South Asian	1.12	0.69	4.97	*0.00*	3.06	0.85	0.56	3.56	*0.00*	2.35
Caribbean	0.05	0.61	0.09	*0.93*	1.05	-0.25	0.46	-0.43	*0.67*	0.78
African	1.62	1.58	5.19	*0.00*	5.06	1.36	1.27	4.16	*0.00*	3.89
European	0.36	0.46	1.10	*0.27*	1.43	0.22	0.41	0.68	*0.49*	1.25
Chinese	-0.61	0.54	-0.61	*0.54*	0.54	-0.82	0.44	-0.81	*0.42*	0.44
Rest of the World	-0.20	0.48	-0.34	*0.73*	0.82	-0.35	0.41	-0.60	*0.55*	0.70
Occupation Type										
Professional/Managerial						**0**				**1**
Skilled						0.23	0.27	1.08	*0.28*	1.26
Unskilled						0.22	0.29	0.92	*0.36*	1.24
Missing						0.72	0.45	3.33	*0.00*	2.06
Education Level										
Degree level						-0.45	0.19	-1.25	*0.21*	0.73
A-level						-0.42	0.24	-1.15	*0.25*	0.65
No 18+ qualificatons						**0**				**1**
Missing	*(Not adjusted for socioeconomic characteristics)*					1.58	1.68	4.54	*0.00*	4.85
Marital Status										
Married						**0**				**1**
Single						1.03	0.51	5.69	*0.00*	2.80
Divorced						0.09	0.24	0.40	*0.69*	1.09
Widowed						0.25	0.21	1.49	*0.14*	1.28
Missing						*(omitted)*				
Area of Residence Type										
Rural						**0**				**1**
London						0.26	0.23	1.46	*0.14*	1.29
Other Urban						0.00	0.16	0.00	*1.00*	1.00
Missing						*(omitted)*				

Source: author's calculations based on ONS LS

[62] Basic (constant) **0.00000002290**; (SE) **0.000000008880**; (z-score) **-45.45**; (p-value) **0.00**; Basic (gamma) **0.0076103**; (SE) **0.0004401**; (z-score) **17.29**; (p-value) **0.00; SES** (constant) **0.00000001160**; (SE) **0.000000005110**; (z-score) **-41.43**; (p-value) **0.00**; SES (gamma) **0.0076725**; (SE) **0.0004517**; (z-score) **16.98**; (p-value) **0.00**

Table D20. Other causes: separate analysis of cause of death (male).[63]

Other causes	Male									
	Basic					SES				
	Log Haz	Std Error	Z-score	P-value	Haz Ratio	Log Haz	Std Error	Z-score	P-value	Haz Ratio
Period										
1971-1981	**0**				**1**	**0**				**1**
1981-1991	-0.10	0.04	-1.99	*0.05*	0.91	-0.18	0.04	-3.67	*0.00*	0.84
1991-2001	-0.03	0.04	-0.75	*0.45*	0.97	-0.25	0.04	-5.33	*0.00*	0.78
2001-2012	0.23	0.06	5.21	*0.00*	1.26	0.00	0.05	-0.08	*0.93*	1.00
Country of birth										
England and Wales	**0**				**1**	**0**				**1**
Scotland	0.31	0.10	4.43	*0.00*	1.37	0.32	0.10	4.53	*0.00*	1.38
Northern Ireland	0.37	0.19	2.92	*0.00*	1.45	0.28	0.17	2.19	*0.03*	1.32
Republic of Ireland	0.18	0.10	2.08	*0.04*	1.20	-0.12	0.08	-1.37	*0.17*	0.89
India	-0.05	0.08	-0.61	*0.55*	0.95	-0.02	0.08	-0.31	*0.76*	0.98
Pakistan	-0.76	0.07	-5.07	*0.00*	0.47	-0.80	0.07	-5.35	*0.00*	0.45
Bangladesh	-0.98	0.10	-3.67	*0.00*	0.37	-1.11	0.09	-4.14	*0.00*	0.33
Jamaica	-0.02	0.15	-0.13	*0.90*	0.98	-0.48	0.10	-3.11	*0.00*	0.62
Other Caribbean	-0.29	0.15	-1.44	*0.15*	0.75	-0.57	0.12	-2.76	*0.01*	0.57
East and Southern Africa	-0.45	0.10	-2.85	*0.00*	0.64	-0.48	0.10	-3.03	*0.00*	0.62
West and Central Africa	-0.34	0.15	-1.59	*0.11*	0.71	-0.54	0.13	-2.51	*0.01*	0.58
Western Europe	-0.26	0.09	-2.30	*0.02*	0.77	-0.32	0.08	-2.80	*0.01*	0.73
Eastern Europe	-0.09	0.14	-0.62	*0.54*	0.91	-0.26	0.12	-1.72	*0.09*	0.77
China	-0.28	0.18	-1.15	*0.25*	0.76	-0.29	0.18	-1.19	*0.23*	0.75
Other Asia	-0.84	0.10	-3.57	*0.00*	0.43	-0.86	0.10	-3.64	*0.00*	0.42
Rest of the World	-0.12	0.09	-1.26	*0.21*	0.88	-0.19	0.08	-1.97	*0.05*	0.82
Occupation Type										
Professional/Managerial						**0**				**1**
Skilled						0.11	0.04	3.21	*0.00*	1.12
Unskilled						0.36	0.06	9.22	*0.00*	1.44
Missing						1.07	0.12	26.63	*0.00*	2.90
Education Level										
Degree level						0.00	0.03	-8.41	*0.00*	0.67
A-level						0.00	0.04	-4.86	*0.00*	0.76
No 18+ qualificatons						**0**				**1**
Missing	*(Not adjusted for socioeconomic characteristics)*					1.70	0.36	25.88	*0.00*	5.50
Marital Status										
Married						**0**				**1**
Single						0.93	0.08	29.84	*0.00*	2.53
Divorced						0.58	0.07	14.48	*0.00*	1.79
Widowed						0.51	0.11	7.95	*0.00*	1.66
Missing						*(omitted)*				
Type of Area										
Rural						**0**				**1**
London						0.04	0.04	1.07	*0.29*	1.04
Other Urban						0.05	0.03	1.62	*0.11*	1.05
Missing						*(omitted)*				

Source: author's calculations based on ONS LS

[63] Basic (constant) **0.00001300**; (SE) **0.0000006490**; (z-score) **-225.95**; (p-value) **0.00**; Basic (gamma) **0.0033705**; (SE) **0.0000697**; (z-score) **48.32**; (p-value) **0.00; SES** (constant) **0.00000405**; (SE) **0.0000697**; (z-score) **-191.89**; (p-value) **0.00**; SES (gamma) **0.0045815**; (SE) **0.0000758**; (z-score) **60.47**; (p-value) **0.00**

Table D21. Other causes: separate analysis of cause of death (female).[64]

Other causes	**Female**									
	Basic					SES				
	Log Haz	Std Error	Z-score	P-value	Haz Ratio	Log Haz	Std Error	Z-score	P-value	Haz Ratio
Period										
1971-1981	**0**				**1**	**0**				**1**
1981-1991	-0.45	0.04	-6.71	*0.00*	0.64	-0.41	0.04	-6.08	*0.00*	0.66
1991-2001	-0.49	0.04	-7.90	*0.00*	0.61	-0.43	0.04	-6.84	*0.00*	0.65
2001-2012	-0.30	0.05	-4.84	*0.00*	0.74	-0.12	0.06	-1.86	*0.06*	0.89
Country of birth										
England and Wales	**0**					**0**				**1**
Scotland	0.34	0.13	3.76	*0.00*	1.41	0.35	0.13	3.82	*0.00*	1.42
Northern Ireland	0.19	0.20	1.10	*0.27*	1.21	0.14	0.20	0.83	*0.41*	1.15
Republic of Ireland	0.20	0.12	2.15	*0.03*	1.23	0.05	0.10	0.52	*0.60*	1.05
India	0.00	0.10	-0.01	*0.99*	1.00	-0.19	0.09	-1.76	*0.08*	0.83
Pakistan	-0.38	0.13	-1.95	*0.05*	0.68	-0.81	0.09	-4.10	*0.00*	0.44
Bangladesh	-0.22	0.22	-0.78	*0.44*	0.80	-0.75	0.13	-2.68	*0.01*	0.47
Jamaica	-0.01	0.17	-0.08	*0.94*	0.99	-0.33	0.13	-1.90	*0.06*	0.72
Other Caribbean	-0.04	0.21	-0.16	*0.87*	0.97	-0.26	0.17	-1.16	*0.24*	0.77
East and Southern Africa	0.08	0.18	0.47	*0.64*	1.08	-0.12	0.15	-0.73	*0.47*	0.89
West and Central Africa	-0.58	0.20	-1.65	*0.10*	0.56	-0.81	0.16	-2.27	*0.02*	0.45
Western Europe	-0.36	0.09	-2.96	*0.00*	0.70	-0.48	0.08	-3.86	*0.00*	0.62
Eastern Europe	-0.27	0.14	-1.43	*0.15*	0.76	-0.38	0.13	-2.02	*0.04*	0.68
China	-1.24	0.17	-2.14	*0.03*	0.29	-1.40	0.14	-2.43	*0.02*	0.25
Other Asia	-0.50	0.14	-2.11	*0.04*	0.61	-0.62	0.13	-2.62	*0.01*	0.54
Rest of the World	0.05	0.12	0.43	*0.67*	1.05	-0.05	0.11	-0.45	*0.65*	0.95
Occupation Type										
Professional/Managerial						**0**				**1**
Skilled						0.02	0.05	0.43	*0.67*	1.02
Unskilled						0.27	0.07	5.00	*0.00*	1.32
Missing						0.83	0.12	16.36	*0.00*	2.30
Education Level										
Degree level						-0.10	0.04	-7.18	*0.00*	0.63
A-level						-0.37	0.06	-4.54	*0.00*	0.69
No 18+ qualificatons						**0**				**1**
Missing	*(Not adjusted for socioeconomic characteristics)*					1.65	0.46	18.70	*0.00*	5.22
Marital Status										
Married						**0**				**1**
Single						0.93	0.11	21.71	*0.00*	2.54
Divorced						0.44	0.07	9.27	*0.00*	1.55
Widowed						0.29	0.06	6.66	*0.00*	1.34
Missing						*(omitted)*				
Type of Area										
Rural						**0**				**1**
London						0.08	0.05	1.77	*0.08*	1.08
Other Urban						0.13	0.04	3.83	*0.00*	1.14
Missing						*(omitted)*				

Source: author's calculations based on ONS LS

64 Basic (constant) **0.000002160**; (SE) **0.0000001500**; (z-score) **-188.03**; (p-value) **0.00**; Basic (gamma) **0.0059872**; (SE) **0.0000964**; (z-score) **62.11**; (p-value) **0.00;** SES (constant) **0.0000009650**; (SE) **0.00000008440**; (z-score) **-158.29**; (p-value) **0.00**; SES (gamma) **0.0062006**; (SE) **0.0001025**; (z-score) **60.49**; (p-value) **0.00**

Table D22. Additional causes of death (sex-adjusted): Ischaemic Heart Disease.[65]

Ischaemic Heart Disease	Basic Model					SES Model				
	Log Haz	S.E	Z-Score	P-value	Haz Ratio	Log Haz	S.E	Z-Score	P-value	Haz Ratio
Sex										
Male	**0**				**1**	**0**				**1**
Female	-1.16	0.01	-46.65	*0.00*	0.31	-1.34	0.01	-51.32	*0.00*	0.26
Period										
1971-81	**0**				**1**	**0**				**1**
1981-91	-0.16	0.04	-3.32	*0.00*	0.85	-0.16	0.04	-3.31	*0.00*	0.85
1991-01	-0.60	0.03	-12.27	*0.00*	0.55	-0.60	0.03	-12.20	*0.00*	0.55
2000-12	-2.14	0.01	-38.30	*0.00*	0.12	-2.06	0.01	-36.60	*0.00*	0.13
Country of birth										
England and Wales	**0**				**1**	**0**				**1**
Scotland	0.26	0.09	3.83	*0.00*	1.30	0.27	0.09	3.93	*0.00*	1.31
Northern Ireland	0.33	0.16	2.84	*0.01*	1.39	0.26	0.15	2.28	*0.02*	1.30
Irish Republic	0.17	0.08	2.38	*0.02*	1.18	0.04	0.07	0.61	*0.55*	1.04
India	0.34	0.09	5.37	*0.00*	1.40	0.22	0.08	3.49	*0.00*	1.25
Pakistan	0.36	0.14	3.66	*0.00*	1.43	0.13	0.11	1.35	*0.18*	1.14
Bangladesh	0.19	0.20	1.16	*0.25*	1.21	-0.11	0.15	-0.65	*0.51*	0.90
Jamaica	-0.35	0.10	-2.45	*0.01*	0.70	-0.54	0.08	-3.74	*0.00*	0.58
Other Caribbean	-0.86	0.10	-3.66	*0.00*	0.42	-0.98	0.09	-4.16	*0.00*	0.37
East and South Africa	0.05	0.16	0.36	*0.72*	1.06	-0.05	0.14	-0.35	*0.73*	0.95
West and Central Africa	-0.43	0.18	-1.55	*0.12*	0.65	-0.57	0.16	-2.04	*0.04*	0.57
Western Europe	-0.26	0.08	-2.63	*0.01*	0.77	-0.33	0.07	-3.33	*0.00*	0.72
Eastern Europe	0.07	0.12	0.58	*0.56*	1.07	-0.04	0.11	-0.32	*0.75*	0.96
China	-0.37	0.19	-1.37	*0.17*	0.69	-0.47	0.17	-1.74	*0.08*	0.63
Other Asia	-0.36	0.15	-1.67	*0.10*	0.70	-0.41	0.14	-1.94	*0.05*	0.66
Rest of the World	-0.36	0.08	-3.05	*0.00*	0.70	-0.39	0.08	-3.24	*0.00*	0.68
Occupation Type										
Professional/Managerial						**0**				**1**
Skilled						0.24	0.04	7.11	*0.00*	1.27
Unskilled						0.45	0.06	12.01	*0.00*	1.57
Missing						0.84	0.09	21.26	*0.00*	2.31
Education Level	*(Socioeconomic characteristics not adjusted for)*									
Degree level +						-0.46	0.03	-8.45	*0.00*	0.63
A-levels						-0.27	0.05	-4.37	*0.00*	0.77
No 18+ qualifications						**0**				**1**
Missing						-0.12	0.04	-2.55	*0.01*	0.89

Source: author's calculations based on ONS LS

[65] Basic (constant) **0.000000300**; (SE) **0.0000000198**; (z-score) **-227.14**; (p-value) **0.00**; Basic (gamma) **0.0102524**; (SE) **0.0000996**; (z-score) **102.91**; (p-value) **0.00; SES** (constant) **0.000000254**; (SE) **0.00000001181**; (z-score) **-212.58**; (p-value) **0.00**; SES (gamma) **0.0101021**; (SE) **0.0000987**; (z-score) **102.35**; (p-value) **0.00**

Table D23. Additional causes of death (sex-adjusted): Stroke.[66]

Stroke	**Basic Model**					**SES Model**				
	Log Haz	S.E	Z-Score	P-value	Haz Ratio	Log Haz	S.E	Z-Score	P-value	Haz Ratio
Sex										
Male	**0**				**1**	**0**				**1**
Female	-0.17	0.04	-4.04	*0.00*	0.84	-0.34	0.03	-7.78	*0.00*	0.71
Period										
1971-81	**0**				**1**	**0**				**1**
1981-91	-0.36	0.06	-3.97	*0.00*	0.69	-0.37	0.06	-4.01	*0.00*	0.69
1991-01	-0.62	0.05	-6.91	*0.00*	0.54	-0.62	0.05	-6.77	*0.00*	0.54
2000-12	-1.46	0.02	-14.76	*0.00*	0.23	-1.36	0.03	-13.55	*0.00*	0.26
Country of birth										
England and Wales	**0**				**1**	**0**				**1**
Scotland	0.05	0.16	0.34	*0.74*	1.05	0.03	0.15	0.23	*0.82*	1.03
Northern Ireland	0.19	0.30	0.79	*0.43*	1.21	0.11	0.27	0.47	*0.64*	1.12
Irish Republic	0.31	0.18	2.40	*0.02*	1.36	0.17	0.15	1.34	*0.18*	1.19
India	0.14	0.16	1.01	*0.31*	1.15	-0.05	0.13	-0.36	*0.72*	0.95
Pakistan	0.32	0.27	1.62	*0.11*	1.38	0.00	0.20	-0.02	*0.98*	1.00
Bangladesh	1.09	0.64	5.07	*0.00*	2.97	0.70	0.43	3.24	*0.00*	2.01
Jamaica	0.38	0.29	1.87	*0.06*	1.46	0.16	0.24	0.81	*0.42*	1.18
Other Caribbean	0.53	0.40	2.22	*0.03*	1.69	0.38	0.35	1.59	*0.11*	1.46
East and South Africa	-0.56	0.22	-1.47	*0.14*	0.57	-0.75	0.18	-1.98	*0.05*	0.47
West and Central Africa	0.71	0.61	2.33	*0.02*	2.03	0.47	0.48	1.54	*0.12*	1.60
Western Europe	0.13	0.17	0.87	*0.39*	1.14	0.02	0.16	0.15	*0.88*	1.02
Eastern Europe	0.25	0.27	1.20	*0.23*	1.29	0.10	0.23	0.50	*0.62*	1.11
China	0.59	0.60	1.77	*0.08*	1.81	0.42	0.51	1.27	*0.21*	1.53
Other Asia	-0.18	0.30	-0.50	*0.61*	0.84	-0.33	0.25	-0.93	*0.35*	0.72
Rest of the World	-0.23	0.17	-1.09	*0.28*	0.80	-0.34	0.15	-1.60	*0.11*	0.71
Occupation Type										
Professional/Managerial						**0**				**1**
Skilled						0.24	0.09	3.42	*0.00*	1.28
Unskilled						0.49	0.13	6.33	*0.00*	1.63
Missing	*(Socioeconomic characteristics not adjusted for)*					0.93	0.19	12.22	*0.00*	2.54
Education Level										
Degree level +						-0.16	0.08	-1.72	*0.09*	0.85
A-levels						-0.15	0.10	-1.33	*0.19*	0.86
No 18+ qualifications						**0**				**1**
Missing						0.14	0.09	1.84	*0.07*	1.16

Source: author's calculations based on ONS LS

[66] Basic (constant) **0.000000129**; (SE) **0.0000000152**; (z-score) **-135.48**; (p-value) **0.00**; Basic (gamma) **0.0088255**; (SE) **0.0001732**; (z-score) **50.96**; (p-value) **0.00;** SES (constant) **0.0000000980**; (SE) **0.0000000128**; (z-score) **-123.99**; (p-value) **0.00**; SES (gamma) **0.0087025**; (SE) **0.0001713**; (z-score) **50.81**; (p-value) **0.00**

Table D24. Additional causes of death (sex-adjusted): Other circulatory diseases.[67]

Other Circulatory	Basic Model					SES Model				
	Log Haz	S.E	Z-Score	P-value	Haz Ratio	Log Haz	S.E	Z-Score	P-value	Haz Ratio
Sex										
Male	**0**				**1**	**0**				**1**
Female	-0.47	0.01	-24.02	*0.00*	0.62	-0.60	0.01	-29.68	*0.00*	0.55
Period										
1971-81	**0**				**1**	**0**				**1**
1981-91	-0.05	0.07	-0.69	*0.49*	0.95	-0.07	0.07	-0.88	*0.38*	0.93
1991-01	-0.22	0.06	-3.00	*0.00*	0.80	-0.23	0.06	-3.13	*0.00*	0.80
2000-12	0.14	0.08	1.90	*0.06*	1.15	0.23	0.09	3.18	*0.00*	1.26
Country of birth										
England and Wales	**0**				**1**	**0**				**1**
Scotland	0.22	0.08	3.41	*0.00*	1.24	0.20	0.08	3.11	*0.00*	1.22
Northern Ireland	0.13	0.13	1.13	*0.26*	1.14	0.04	0.12	0.36	*0.72*	1.04
Irish Republic	0.31	0.08	5.15	*0.00*	1.37	0.15	0.07	2.41	*0.02*	1.16
India	0.13	0.07	2.08	*0.04*	1.14	-0.08	0.06	-1.19	*0.23*	0.93
Pakistan	0.03	0.11	0.26	*0.80*	1.03	-0.32	0.07	-3.13	*0.00*	0.72
Bangladesh	0.32	0.20	2.21	*0.03*	1.37	-0.10	0.13	-0.71	*0.48*	0.90
Jamaica	0.42	0.14	4.55	*0.00*	1.52	0.15	0.11	1.59	*0.11*	1.16
Other Caribbean	0.33	0.17	2.70	*0.01*	1.39	0.13	0.14	1.05	*0.30*	1.14
East and South Africa	-0.35	0.11	-2.28	*0.02*	0.70	-0.58	0.09	-3.76	*0.00*	0.56
West and Central Africa	0.69	0.28	4.92	*0.00*	1.98	0.42	0.21	3.03	*0.00*	1.53
Western Europe	-0.10	0.07	-1.20	*0.23*	0.91	-0.23	0.06	-2.84	*0.00*	0.79
Eastern Europe	0.14	0.12	1.36	*0.17*	1.15	-0.06	0.10	-0.58	*0.56*	0.94
China	0.09	0.21	0.47	*0.64*	1.09	-0.09	0.18	-0.44	*0.66*	0.92
Other Asia	-0.44	0.12	-2.40	*0.02*	0.65	-0.61	0.10	-3.33	*0.00*	0.54
Rest of the World	-0.19	0.08	-1.97	*0.05*	0.83	-0.31	0.07	-3.23	*0.00*	0.74
Occupation Type										
Professional/Managerial						**0**				**1**
Skilled						0.14	0.04	4.52	*0.00*	1.15
Unskilled						0.41	0.05	11.82	*0.00*	1.50
Missing						0.88	0.08	25.60	*0.00*	2.41
Education Level	*(Socioeconomic characteristics not adjusted for)*									
Degree level +						-0.29	0.03	-7.30	*0.00*	0.75
A-levels						-0.15	0.05	-2.62	*0.01*	0.86
No 18+ qualifications						**0**				**1**
Missing						0.21	0.05	5.76	*0.00*	1.23

Source: author's calculations based on ONS LS

[67] Basic (constant) **0.000000120**; (SE) **0.00000000949**; (z-score) **-201.91**; (p-value) **0.00**; Basic (gamma) **0.0096855**; (SE) **0.0000824**; (z-score) **117.57**; (p-value) **0.00; SES** (constant) **0.000000100**; (SE) **0.00000000829**; (z-score) **-195.19**; (p-value) **0.00**; SES (gamma) **0.0095146**; (SE) **0.0000821**; (z-score) **115.96**; (p-value) **0.00**

Table D25. Additional causes of death (sex-adjusted): Diabetes.[68]

Diabetes	Basic Model					SES Model				
	Log Haz	S.E	Z-Score	P-value	Haz Ratio	Log Haz	S.E	Z-Score	P-value	Haz Ratio
Sex										
Male	**0**				**1**	**0**				**1**
Female	-0.34	0.05	-4.94	*0.00*	0.71	-0.55	0.04	-7.51	*0.00*	0.58
Period										
1971-81	**0**				**1**	**0**				**1**
1981-91	0.01	0.22	0.03	*0.98*	1.01	-0.03	0.21	-0.15	*0.88*	0.97
1991-01	0.14	0.24	0.70	*0.48*	1.15	0.09	0.24	0.42	*0.68*	1.09
2000-12	0.09	0.23	0.45	*0.65*	1.10	0.07	0.23	0.33	*0.74*	1.07
Country of birth										
England and Wales	**0**				**1**	**0**				**1**
Scotland	0.34	0.31	1.55	*0.12*	1.41	0.34	0.31	1.55	*0.12*	1.41
Northern Ireland	-0.15	0.43	-0.29	*0.77*	0.86	-0.24	0.39	-0.48	*0.63*	0.79
Irish Republic	-0.10	0.25	-0.37	*0.71*	0.90	-0.32	0.21	-1.12	*0.26*	0.73
India	1.04	0.43	6.90	*0.00*	2.84	0.86	0.37	5.49	*0.00*	2.35
Pakistan	0.75	0.55	2.87	*0.00*	2.12	0.41	0.40	1.53	*0.13*	1.50
Bangladesh	1.37	1.20	4.51	*0.00*	3.94	0.95	0.80	3.07	*0.00*	2.58
Jamaica	1.47	0.91	7.09	*0.00*	4.37	1.12	0.65	5.27	*0.00*	3.06
Other Caribbean	1.13	0.94	3.71	*0.00*	3.09	0.87	0.74	2.84	*0.01*	2.40
East and South Africa	0.72	0.66	2.27	*0.02*	2.06	0.51	0.54	1.58	*0.11*	1.66
West and Central Africa	-0.08	0.66	-0.11	*0.91*	0.92	-0.37	0.49	-0.52	*0.60*	0.69
Western Europe	0.24	0.32	0.95	*0.34*	1.27	0.12	0.29	0.48	*0.63*	1.13
Eastern Europe	-0.37	0.35	-0.73	*0.47*	0.69	-0.61	0.27	-1.21	*0.23*	0.55
China	-0.61	0.54	-0.61	*0.54*	0.54	-0.79	0.46	-0.79	*0.43*	0.46
Other Asia	-0.21	0.47	-0.36	*0.72*	0.81	-0.40	0.39	-0.69	*0.49*	0.67
Rest of the World	0.04	0.32	0.15	*0.88*	1.05	-0.11	0.27	-0.36	*0.72*	0.89
Occupation Type										
Professional/Managerial						**0**				**1**
Skilled						0.50	0.21	3.99	*0.00*	1.65
Unskilled						0.50	0.23	3.61	*0.00*	1.66
Missing			*(Socioeconomic characteristics not adjusted for)*			1.30	0.48	9.92	*0.00*	3.66
Education Level										
Degree level +						-0.19	0.13	-1.24	*0.22*	0.83
A-levels						-0.06	0.19	-0.32	*0.75*	0.94
No 18+ qualifications						**0**				**1**
Missing						-0.18	0.16	-0.94	*0.35*	0.84

Source: author's calculations based on ONS LS

[68] Basic (constant) **0.0000000365**; (SE) **0.00000000833**; (z-score) **-74.97**; (p-value) **0.00**; Basic (gamma) **0.0077431**; (SE) **0.000258**; (z-score) **30.02**; (p-value) **0.00; SES** (constant) **0.0000000159**; (SE) **0.00000000413**; (z-score) **-68.90**; (p-value) **0.00**; SES (gamma) **0.0078992**; (SE) **0.00026**; (z-score) **30.38**; (p-value) **0.00**

Table D26. Additional causes of death (sex-adjusted): Lung cancer.[69]

Lung Cancer	Basic Model					SES Model				
	Log Haz	S.E	Z-Score	P-value	Haz Ratio	Log Haz	S.E	Z-Score	P-value	Haz Ratio
Sex										
Male	**0**				**1**	**0**				**1**
Female	-0.74	0.02	-16.11	*0.00*	0.48	-0.89	0.02	-18.12	*0.00*	0.41
Period										
1971-81	**0**				**1**	**0**				**1**
1981-91	-0.10	0.08	-1.09	*0.27*	0.90	-0.09	0.08	-0.98	*0.33*	0.91
1991-01	-0.52	0.06	-5.34	*0.00*	0.60	-0.48	0.06	-4.99	*0.00*	0.62
2000-12	-22.30	0.00	-0.03	*0.98*	0.00	-22.11	0.00	-0.03	*0.98*	0.00
Country of birth										
England and Wales	**0**				**1**	**0**				**1**
Scotland	0.45	0.19	3.74	*0.00*	1.58	0.48	0.20	3.90	*0.00*	1.61
Northern Ireland	0.42	0.33	1.94	*0.05*	1.52	0.36	0.31	1.69	*0.09*	1.44
Irish Republic	0.30	0.17	2.45	*0.01*	1.36	0.20	0.15	1.58	*0.11*	1.22
India	-0.87	0.10	-3.79	*0.00*	0.42	-0.96	0.09	-4.15	*0.00*	0.38
Pakistan	-1.24	0.13	-2.76	*0.01*	0.29	-1.40	0.11	-3.13	*0.00*	0.25
Bangladesh	-0.89	0.24	-1.54	*0.12*	0.41	-1.14	0.19	-1.97	*0.05*	0.32
Jamaica	-0.30	0.20	-1.12	*0.26*	0.74	-0.46	0.17	-1.70	*0.09*	0.63
Other Caribbean	-1.31	0.16	-2.26	*0.02*	0.27	-1.40	0.14	-2.42	*0.02*	0.25
East and South Africa	-2.20	0.11	-2.20	*0.03*	0.11	-2.24	0.11	-2.24	*0.03*	0.11
West and Central Africa	-19.01	0.00	0.00	*1.00*	0.00	-19.01	0.00	0.00	*1.00*	0.00
Western Europe	-0.39	0.14	-1.91	*0.06*	0.68	-0.43	0.13	-2.13	*0.03*	0.65
Eastern Europe	-0.40	0.18	-1.49	*0.14*	0.67	-0.47	0.17	-1.75	*0.08*	0.63
China	-0.47	0.36	-0.81	*0.42*	0.63	-0.51	0.35	-0.89	*0.38*	0.60
Other Asia	-0.58	0.28	-1.17	*0.24*	0.56	-0.55	0.29	-1.09	*0.28*	0.58
Rest of the World	-0.83	0.13	-2.73	*0.01*	0.44	-0.78	0.14	-2.59	*0.01*	0.46
Occupation Type										
Professional/Managerial	*(Socioeconomic characteristics not adjusted for)*					**0**				**1**
Skilled						0.24	0.09	3.41	*0.00*	1.27
Unskilled						0.58	0.13	7.64	*0.00*	1.78
Missing						0.61	0.15	7.51	*0.00*	1.85
Education Level										
Degree level +						-0.95	0.06	-5.83	*0.00*	0.39
A-levels						-0.53	0.08	-4.04	*0.00*	0.59
No 18+ qualifications						**0**				**1**
Missing						-0.11	0.09	-1.15	*0.25*	0.89

Source: author's calculations based on ONS LS

[69] Basic (constant) **0.0000000377**; (SE) **0.00000000540**; (z-score) **-119.26**; (p-value) **0.00**; Basic (gamma) **0.0115145**; (SE) **0.0002244**; (z-score) **51.32**; (p-value) **0.00; SES** (constant) **0.0000000335**; (SE) **0.00000000516**; (z-score) **-111.76**; (p-value) **0.00**; SES (gamma) **0.0113187**; (SE) **0.0002229**; (z-score) **50.78**; (p-value) **0.00**

Table D27. Additional causes of death (sex-adjusted): Alcohol-related mortality.[70]

Alcohol-related	Basic Model					SES Model				
	Log Haz	S.E	Z-Score	P-value	Haz Ratio	Log Haz	S.E	Z-Score	P-value	Haz Ratio
Sex										
Male	**0**				**1**	**0**				**1**
Female	-0.65	0.03	-12.44	*0.00*	0.52	-0.73	0.03	-13.45	*0.00*	0.48
Period										
1971-81	**0**				**1**	**0**				**1**
1981-91	0.95	0.41	6.01	*0.00*	2.59	0.76	0.34	4.79	*0.00*	2.14
1991-01	1.21	0.51	7.95	*0.00*	3.35	0.94	0.41	5.87	*0.00*	2.55
2000-12	1.41	0.62	9.32	*0.00*	4.09	1.14	0.48	7.37	*0.00*	3.11
Country of birth										
England and Wales	**0**				**1**	**0**				**1**
Scotland	0.64	0.26	4.74	*0.00*	1.90	0.58	0.24	4.29	*0.00*	1.79
Northern Ireland	0.71	0.48	2.99	*0.00*	2.03	0.57	0.42	2.39	*0.02*	1.76
Irish Republic	0.66	0.29	4.37	*0.00*	1.93	0.39	0.23	2.60	*0.01*	1.48
India	0.43	0.22	3.10	*0.00*	1.54	0.20	0.18	1.43	*0.15*	1.23
Pakistan	-0.85	0.15	-2.40	*0.02*	0.43	-1.20	0.11	-3.38	*0.00*	0.30
Bangladesh	-2.06	0.13	-2.06	*0.04*	0.13	-2.48	0.08	-2.47	*0.01*	0.08
Jamaica	-0.60	0.24	-1.35	*0.18*	0.55	-1.09	0.15	-2.42	*0.02*	0.34
Other Caribbean	-0.11	0.37	-0.26	*0.79*	0.90	-0.49	0.25	-1.19	*0.23*	0.61
East and South Africa	-0.07	0.26	-0.27	*0.79*	0.93	-0.36	0.20	-1.27	*0.21*	0.70
West and Central Africa	-1.88	0.15	-1.88	*0.06*	0.15	-2.36	0.09	-2.36	*0.02*	0.09
Western Europe	-0.25	0.18	-1.08	*0.28*	0.78	-0.46	0.15	-2.00	*0.05*	0.63
Eastern Europe	-0.42	0.25	-1.11	*0.27*	0.66	-0.81	0.17	-2.13	*0.03*	0.45
China	-1.53	0.22	-1.53	*0.13*	0.22	-1.77	0.17	-1.77	*0.08*	0.17
Other Asia	-0.37	0.26	-0.98	*0.33*	0.69	-0.66	0.20	-1.74	*0.08*	0.52
Rest of the World	-0.26	0.17	-1.17	*0.24*	0.77	-0.55	0.13	-2.47	*0.01*	0.58
Occupation Type										
Professional/Managerial						**0**				**1**
Skilled						0.00	0.08	0.00	*1.00*	1.00
Unskilled						0.28	0.12	3.11	*0.00*	1.32
Missing	*(Socioeconomic characteristics not adjusted for)*					0.66	0.18	7.10	*0.00*	1.93
Education Level										
Degree level +						-0.32	0.10	-2.27	*0.02*	0.73
A-levels						-0.24	0.08	-2.33	*0.02*	0.79
No 18+ qualifications						**0**				**1**
Missing						0.85	0.40	4.92	*0.00*	2.34

Source: author's calculations based on ONS LS

70 Basic (constant) **0.000000633**; (SE) **0.000000100**; (z-score) **-90.01**; (p-value) **0.00**; Basic (gamma) **0.0032384**; (SE) **0.0001462**; (z-score) **22.14**; (p-value) **0.00**; SES (constant) **0.000000347**; (SE) **0.0000000640**; (z-score) **-80.75**; (p-value) **0.00**; SES (gamma) **0.0037913**; (SE) **0.0001634**; (z-score) **23.20**; (p-value) **0.00**

Table D28. Additional causes of death (sex-adjusted): Accidents and violence.[71]

Accidents	Basic Model					SES Model				
	Log Haz	S.E	Z-Score	P-value	Haz Ratio	Log Haz	S.E	Z-Score	P-value	Haz Ratio
Sex										
Male	**0**				**1**	**0**				**1**
Female	-1.01	0.01	-26.06	*0.00*	0.36	-1.13	0.01	-28.20	*0.00*	0.32
Period										
1971-81	**0**				**1**	**0**				**1**
1981-91	1.29	0.31	15.30	*0.00*	3.64	1.22	0.29	14.41	*0.00*	3.39
1991-01	1.26	0.30	14.99	*0.00*	3.52	1.19	0.28	14.12	*0.00*	3.30
2000-12	1.09	0.25	12.93	*0.00*	2.98	1.06	0.25	12.49	*0.00*	2.90
Country of birth										
England and Wales	**0**				**1**	**0**				**1**
Scotland	0.39	0.16	3.65	*0.00*	1.48	0.39	0.16	3.65	*0.00*	1.48
Northern Ireland	0.47	0.30	2.49	*0.01*	1.59	0.40	0.28	2.13	*0.03*	1.49
Irish Republic	0.21	0.17	1.54	*0.12*	1.24	0.06	0.15	0.41	*0.69*	1.06
India	-0.12	0.11	-0.93	*0.35*	0.89	-0.30	0.10	-2.36	*0.02*	0.74
Pakistan	-1.03	0.09	-4.11	*0.00*	0.36	-1.32	0.07	-5.27	*0.00*	0.27
Bangladesh	-1.34	0.12	-2.98	*0.00*	0.26	-1.69	0.08	-3.77	*0.00*	0.18
Jamaica	-0.10	0.23	-0.38	*0.70*	0.91	-0.33	0.19	-1.28	*0.20*	0.72
Other Caribbean	-0.48	0.22	-1.37	*0.17*	0.62	-0.63	0.19	-1.77	*0.08*	0.53
East and South Africa	-0.41	0.14	-1.94	*0.05*	0.66	-0.59	0.12	-2.73	*0.01*	0.56
West and Central Africa	-1.35	0.13	-2.69	*0.01*	0.26	-1.63	0.10	-3.26	*0.00*	0.20
Western Europe	-0.30	0.12	-1.85	*0.06*	0.74	-0.43	0.11	-2.60	*0.01*	0.65
Eastern Europe	0.05	0.23	0.25	*0.80*	1.06	-0.22	0.17	-1.03	*0.30*	0.80
China	-0.29	0.26	-0.83	*0.41*	0.75	-0.47	0.22	-1.33	*0.19*	0.62
Other Asia	-0.85	0.14	-2.67	*0.01*	0.43	-1.04	0.11	-3.27	*0.00*	0.35
Rest of the World	-0.42	0.10	-2.69	*0.01*	0.66	-0.61	0.09	-3.88	*0.00*	0.54
Occupation Type										
Professional/Managerial						**0**				**1**
Skilled						0.10	0.06	1.67	*0.09*	1.10
Unskilled						0.46	0.10	7.23	*0.00*	1.58
Missing						0.84	0.15	13.25	*0.00*	2.32
Education Level			*(Socioeconomic characteristics not adjusted for)*							
Degree level +						-0.29	0.06	-3.76	*0.00*	0.75
A-levels						-0.18	0.07	-2.07	*0.04*	0.84
No 18+ qualifications						**0**				**1**
Missing						0.15	0.07	2.44	*0.02*	1.16

Source: author's calculations based on ONS LS

[71] Basic (constant) **0.00000861**; (SE) **0.000000767**; (z-score) **-130.92**; (p-value) **0.00**; Basic (gamma) **0.0003902**; (SE) **0.0001021**; (z-score) **3.82**; (p-value) **0.00;** SES (constant) **0.00000544**; (SE) **0.000000565**; (z-score) **-116.52**; (p-value) **0.00**; SES (gamma) **0.0008029**; (SE) **0.0001015**; (z-score) **7.91**; (p-value) **0.00**

Table D29. Additional causes of death (sex-adjusted): Mental and behavioural.[72]

Mental & Behavioural	Basic Model					SES Model				
	Log Haz	S.E	Z-Score	P-value	Haz Ratio	Log Haz	S.E	Z-Score	P-value	Haz Ratio
Sex										
Male	**0**				**1**	**0**				**1**
Female	-0.21	0.05	-3.19	*0.00*	0.81	-0.41	0.05	-6.02	*0.00*	0.66
Period										
1971-81	**0**				**1**	**0**				**1**
1981-91	-0.05	0.26	-0.17	*0.87*	0.95	-0.12	0.24	-0.42	*0.67*	0.89
1991-01	0.35	0.35	1.40	*0.16*	1.41	0.30	0.34	1.21	*0.23*	1.35
2000-12	1.06	0.70	4.34	*0.00*	2.88	1.19	0.80	4.83	*0.00*	3.28
Country of birth										
England and Wales	**0**				**1**	**0**				**1**
Scotland	0.25	0.27	1.18	*0.24*	1.28	0.19	0.26	0.89	*0.38*	1.21
Northern Ireland	-0.33	0.36	-0.65	*0.52*	0.72	-0.51	0.30	-1.01	*0.31*	0.60
Irish Republic	0.36	0.30	1.76	*0.08*	1.44	0.05	0.22	0.23	*0.82*	1.05
India	-0.38	0.19	-1.39	*0.16*	0.69	-0.81	0.12	-3.00	*0.00*	0.44
Pakistan	-1.51	0.16	-2.14	*0.03*	0.22	-2.20	0.08	-3.11	*0.00*	0.11
Bangladesh	-1.28	0.28	-1.28	*0.20*	0.28	-2.08	0.13	-2.07	*0.04*	0.13
Jamaica	-0.06	0.39	-0.14	*0.89*	0.94	-0.57	0.23	-1.40	*0.16*	0.56
Other Caribbean	0.16	0.53	0.36	*0.72*	1.18	-0.24	0.35	-0.53	*0.60*	0.79
East and South Africa	-0.49	0.31	-0.98	*0.33*	0.61	-0.98	0.19	-1.95	*0.05*	0.38
West and Central Africa	-1.07	0.34	-1.07	*0.28*	0.34	-1.65	0.19	-1.65	*0.10*	0.19
Western Europe	-0.33	0.22	-1.10	*0.27*	0.72	-0.62	0.16	-2.05	*0.04*	0.54
Eastern Europe	-0.14	0.36	-0.35	*0.73*	0.87	-0.61	0.22	-1.50	*0.13*	0.54
China	-0.85	0.43	-0.85	*0.40*	0.43	-1.24	0.29	-1.24	*0.21*	0.29
Other Asia	-14.69	0.00	-0.02	*0.98*	0.00	-14.65	0.00	-0.03	*0.98*	0.00
Rest of the World	0.27	0.31	1.14	*0.25*	1.31	-0.09	0.22	-0.38	*0.71*	0.91
Occupation Type										
Professional/Managerial						**0**				**1**
Skilled						0.10	0.14	0.78	*0.44*	1.10
Unskilled						0.63	0.25	4.81	*0.00*	1.88
Missing						1.64	0.63	13.44	*0.00*	5.18
Education Level	*(Socioeconomic characteristics not adjusted for)*									
Degree level +						-0.68	0.13	-2.57	*0.01*	0.51
A-levels						-0.25	0.11	-1.75	*0.08*	0.78
No 18+ qualifications						**0**				**1**
Missing						0.29	0.14	2.87	*0.00*	1.34

Source: author's calculations based on ONS LS

[72] Basic (constant) **0.0000000352**; (SE) **0.00000000909**; (z-score) **-66.52**; (p-value) **0.00**; Basic (gamma) **0.0070327**; (SE) **0.0002316**; (z-score) **30.37**; (p-value) **0.00; SES** (constant) **0.0000000209**; (SE) **0.00000000575**; (z-score) **-64.32**; (p-value) **0.00**; SES (gamma) **0.006911**; (SE) **0.0002241**; (z-score) **30.83**; (p-value) **0.00**

Appendix E: Chapter IV

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Table E1. Model 1a from Chapter IV with log relative hazard, standard errors, z-score and p-values.[73]

Model 1	[a]					Male					Female				
	Log Haz	S.E	Z-score	P-value	Haz Ratio	Log Haz	S.E	Z-score	P-value	Haz Ratio	Log Haz	S.E	Z-score	P-value	Haz Ratio
Sex															
Male	**0**				**1**	*(Sex-stratified)*					*(Sex-stratified)*				
Female	-0.42	0.01	-45.63	*0.00*	0.66										
Period															
1991-2001	**0**				**1**	**0**				**1**	**0**				**1**
2001-2012	-0.14	0.01	-13.09	*0.00*	0.87	-0.16	0.01	-11.70	*0.00*	0.85	-0.11	0.02	-6.44	*0.00*	0.90
Ethnicity/country of birth															
White England and Wales	**0**				**1**	**0**				**1**	**0**				**1**
White Other UK/Ireland	0.21	0.03	10.34	*0.00*	1.23	0.20	0.03	7.33	*0.00*	1.22	0.23	0.04	7.34	*0.00*	1.26
Immigrants	-0.22	0.01	-13.37	*0.00*	0.80	-0.22	0.02	-9.98	*0.00*	0.80	-0.23	0.02	-8.85	*0.00*	0.79
Descendants	0.32	0.09	4.99	*0.00*	1.37	0.30	0.11	3.57	*0.00*	1.35	0.35	0.14	3.52	*0.00*	1.41

Source: author's calculations based on ONS LS

[73] [a] (constant) **0.00000273**; (SE) **0.0000000712**; (z-score) **-492.00**; (p-value) **0.00**; [a] (gamma) **0.0080225**; (SE) **0.0000342**; (z-score) **234.58**; (p-value) **0.00**; Male (constant) **0.00000309**; (SE) **0.0000000445**; (z-score) -**379.34**; (p-value) **0.00**; Male (gamma) **0.007885**; (SE) **0.0000445**; (z-score) **177.19**; (p-value) **0.00**; Female (constant) **0.00000151**; (SE) **0.0000000616**; (z-score) – -**327.76**; (p-value) **0.00**; Female (gamma) **0.0082124**; (SE) **0.0000535**; (z-score) **153.53**; (p-value) **0.00**

Table E2. Model 1b from Chapter IV with log relative hazard, standard errors, z-score and p-values.

Model 1	[b]					Male					Female				
	Log Haz	S.E	Z-score	P-value	Haz Ratio	Log Haz	S.E	Z-score	P-value	Haz Ratio	Log Haz	S.E	Z-score	P-value	Haz Ratio
Sex															
Male	**0**				**1**	*(Sex-stratified)*					*(Sex-stratified)*				
Female	-0.53	0.01	-54.41	*0.00*	0.59										
Period															
1991-2001	**0**				**1**	**0**				**1**	**0**				**1**
2001-2012	-0.07	0.01	-6.52	*0.00*	0.93	-0.13	0.01	-9.21	*0.00*	0.88	0.01	0.02	0.73	*0.46*	1.01
Ethnicity/country of birth															
White (England and Wales)	**0**				**1**	**0**				**1**	**0**				**1**
White (Other UK/Ireland)	0.14	0.02	6.75	*0.00*	1.15	0.11	0.03	4.00	*0.00*	1.11	0.18	0.04	5.63	*0.00*	1.19
Immigrants	-0.31	0.01	-17.42	*0.00*	0.73	-0.29	0.02	-12.46	*0.00*	0.75	-0.34	0.02	-12.25	*0.00*	0.71
Descendants	0.00	0.06	-0.02	*0.99*	1.00	-0.02	0.08	-0.29	*0.78*	0.98	0.03	0.10	0.34	*0.74*	1.03
Occupation Type															
Professional/Managerial	**0**				**1**	**0**				**1**	**0**				**1**
Skilled	0.11	0.02	7.67	*0.00*	1.11	0.14	0.02	8.17	*0.00*	1.15	0.03	0.02	1.33	*0.18*	1.03
Unskilled	0.25	0.02	15.88	*0.00*	1.28	0.24	0.03	12.27	*0.00*	1.27	0.22	0.03	8.76	*0.00*	1.25
Missing	0.60	0.03	37.42	*0.00*	1.81	0.65	0.04	30.24	*0.00*	1.91	0.54	0.04	21.56	*0.00*	1.71
Education Level															
Degree level +	**0**				**1**	**0**				**1**	**0**				**1**
A-levels	-0.32	0.01	-17.50	*0.00*	0.73	-0.33	0.02	-14.57	*0.00*	0.72	-0.30	0.02	-10.13	*0.00*	0.74
No 18+ qualifications	-0.17	0.02	-6.88	*0.00*	0.84	-0.16	0.03	-5.07	*0.00*	0.85	-0.19	0.03	-4.58	*0.00*	0.83
Missing	-0.08	0.08	-0.85	*0.40*	0.93	0.06	0.12	0.58	*0.56*	1.07	-0.29	0.11	-1.96	*0.05*	0.75

Source: author's calculations based on ONS LS

Table E2 (continued)[74]

Model 1	[b]					Male					Female				
	Log Haz	S.E	Z-score	P-value	Haz Ratio	Log Haz	S.E	Z-score	P-value	Haz Ratio	Log Haz	S.E	Z-score	P-value	Haz Ratio
Housing Tenure															
Owned	**0**				**1**	**0**				**1**	**0**				**1**
Private Renting	0.46	0.02	39.88	*0.00*	1.58	0.46	0.02	30.14	*0.00*	1.59	0.45	0.03	25.62	*0.00*	1.56
Social Renting	0.23	0.02	11.65	*0.00*	1.25	0.23	0.03	9.06	*0.00*	1.25	0.22	0.04	7.04	*0.00*	1.24
Missing	1.11	0.09	39.06	*0.00*	3.03	0.97	0.10	25.12	*0.00*	2.64	1.27	0.15	30.34	*0.00*	3.56
Area of Residence Type															
Rural	**0**				**1**	**0**				**1**	**0**				**1**
London	0.01	0.02	0.88	*0.38*	1.01	0.03	0.02	1.75	*0.08*	1.04	-0.01	0.02	-0.60	*0.55*	0.99
Other Urban	0.11	0.01	9.78	*0.00*	1.11	0.09	0.02	6.49	*0.00*	1.10	0.12	0.02	7.23	*0.00*	1.13
Marital Status															
Married	**0**				**1**	**0**				**1**	**0**				**1**
Single	0.39	0.02	26.54	*0.00*	1.48	0.43	0.03	23.44	*0.00*	1.53	0.32	0.04	12.41	*0.00*	1.38
Divorced	0.23	0.02	15.55	*0.00*	1.26	0.26	0.03	13.22	*0.00*	1.29	0.19	0.03	8.25	*0.00*	1.21
Widowed	0.14	0.02	9.83	*0.00*	1.16	0.21	0.03	8.50	*0.00*	1.23	0.10	0.02	5.06	*0.00*	1.10

Source: author's calculations based on ONS LS

[74] [b] (constant) **0.00000199**; (SE) **0.0000000587**; (z-score) **-444.57**; (p-value) **0.00**; [a] (gamma) **0.0079381**; (SE) **0.0000355**; (z-score) **223.71**; (p-value) **0.00**; Male (constant) **0.00000195**; (SE) **0.0000000732**; (z-score) -**349.58**; (p-value) **0.00**; Male (gamma) **0.0079793**; (SE) **0.0000458**; (z-score) **174.40**; (p-value) **0.00**; Female (constant) **0.00000124**; (SE) **0.0000000587**; (z-score) **-288.51**; (p-value) **0.00**; Female (gamma) **0.0078734**; (SE) **0.0000564**; (z-score) **139.68**; (p-value) **0.00**

Table E3. Model 2 from Chapter IV with log relative hazard, standard errors, z-score and p-values.

Model 2	[a]					[b]				
	Log Haz	S.E	Z-score	P-value	Haz Ratio	Log Haz	S.E	Z-score	P-value	Haz Ratio
Sex										
Male	**0**				**1**	**0**				**1**
Female	-0.42	0.01	-45.63	*0.00*	0.66	-0.53	0.01	-54.47	*0.00*	0.59
Period										
1991-2001	**0**				**1**	**0**				**1**
2001-2012	-0.14	0.01	-12.94	*0.00*	0.87	-0.07	0.01	-6.29	*0.00*	0.93
Ethnicity by country of birth										
White England and Wales	**0**				**1**	**0**				**1**
White Scottish	0.21	0.04	7.04	*0.00*	1.23	0.23	0.04	7.56	*0.00*	1.25
White Northern Irish	0.21	0.07	3.84	*0.00*	1.23	0.13	0.06	2.42	*0.02*	1.14
White Irish	0.21	0.04	6.82	*0.00*	1.23	0.05	0.03	1.58	*0.12*	1.05
Immigrants										
White	-0.21	0.02	-7.96	*0.00*	0.81	-0.22	0.02	-8.18	*0.00*	0.81
Indian	-0.19	0.03	-5.46	*0.00*	0.83	-0.19	0.03	-5.48	*0.00*	0.83
Pakistani	-0.21	0.04	-4.25	*0.00*	0.81	-0.36	0.04	-7.08	*0.00*	0.70
Bangladeshi	-0.19	0.07	-2.31	*0.02*	0.83	-0.55	0.05	-6.64	*0.00*	0.58
Chinese	-0.41	0.07	-4.12	*0.00*	0.66	-0.52	0.06	-5.14	*0.00*	0.60
Other Asian	-0.81	0.05	-7.76	*0.00*	0.44	-0.91	0.04	-8.63	*0.00*	0.40
Black Caribbean	-0.11	0.04	-2.18	*0.03*	0.90	-0.36	0.04	-7.15	*0.00*	0.70
Black African	-0.31	0.06	-3.77	*0.00*	0.74	-0.57	0.05	-7.01	*0.00*	0.56
Black Other	0.24	0.21	1.41	*0.16*	1.27	-0.09	0.15	-0.55	*0.58*	0.91
Mixed: Black/White	-0.03	0.19	-0.17	*0.87*	0.97	-0.37	0.14	-1.87	*0.06*	0.69
Mixed: Asian/White	-0.18	0.16	-0.92	*0.36*	0.84	-0.15	0.17	-0.78	*0.44*	0.86
Other	-0.43	0.06	-4.40	*0.00*	0.65	-0.62	0.05	-6.27	*0.00*	0.54
Descendants										
Indian	0.03	0.19	0.17	*0.87*	1.03	-0.13	0.16	-0.72	*0.47*	0.88
Pakistani & Bangladeshi	0.58	0.31	3.32	*0.00*	1.79	0.28	0.23	1.58	*0.11*	1.32
Chinese & Other Asian	-2.03	0.13	-2.03	*0.04*	0.13	-2.34	0.10	-2.34	*0.02*	0.10
Black Caribbean	0.83	0.30	6.42	*0.00*	2.30	0.53	0.22	4.07	*0.00*	1.70
Black African	-0.17	0.18	-0.80	*0.43*	0.84	-0.55	0.12	-2.58	*0.01*	0.58
Black Other	0.77	0.50	3.36	*0.00*	2.16	0.32	0.32	1.38	*0.17*	1.37
Mixed: Black/White	0.13	0.19	0.78	*0.43*	1.14	-0.29	0.12	-1.74	*0.08*	0.75
Mixed: Asian/White	-0.28	0.23	-0.94	*0.35*	0.75	-0.41	0.20	-1.37	*0.17*	0.66
Other	0.61	0.29	3.91	*0.00*	1.84	0.21	0.19	1.33	*0.18*	1.23
Occupation Type										
Professional/Managerial	*(Not adjusted for socioeconomic characteristics)*					**0**				**1**
Skilled						0.11	0.02	7.73	*0.00*	1.11
Unskilled						0.25	0.02	16.01	*0.00*	1.28
Missing						0.60	0.03	37.59	*0.00*	1.82
Education Level										
Degree level +						-0.32	0.01	-17.54	*0.00*	0.73
A-levels						-0.17	0.02	-6.92	*0.00*	0.84
No 18+ qualifications						**0**				**1**
Missing						-0.05	0.09	-0.61	*0.55*	0.95

Source: author's calculations based on ONS LS

Table E3 (continued).[75]

Model 2	**[a]**					**[b]**				
	Log Haz	S.E	Z-score	P-value	Haz Ratio	Log Haz	S.E	Z-score	P-value	Haz Ratio
Housing Tenure										
Owned						**0**				**1**
Private Renting						0.46	0.02	40.21	*0.00*	1.59
Social Renting						0.23	0.02	11.85	*0.00*	1.26
Missing						1.11	0.09	39.15	*0.00*	3.04
Area of Residence Type										
Rural	*(Not adjusted for socioeconomic characteristics)*					**0**				**1**
London						0.03	0.02	1.71	*0.09*	1.03
Other Urban						0.11	0.01	10.00	*0.00*	1.12
Marital Status										
Married						**0**				**1**
Single						0.39	0.02	26.39	*0.00*	1.48
Divorced						0.23	0.02	15.46	*0.00*	1.26
Widowed						0.14	0.02	9.76	*0.00*	1.15

Source: author's calculations based on ONS LS

75 [a] (constant) **0.00000275**; (SE) **0.0000000717**; (z-score) **-490.97**; (p-value) **0.00**; [a] (gamma) **0.0080155**; (SE) **0.0000343**; (z-score) **233.90**; (p-value) **0.00**; [b] (constant) **0.00000199**; (SE) **0.0000000589**; (z-score) **-443.41**; (p-value) **0.00**; [b] (gamma) **0.00793**; (SE) **0.0000356**; (z-score) **222.76**; (p-value) **0.00**

Table E4. Model 2 (sex-stratified) with log relative hazard, standard errors, z-score and p-values.

Model 2	Male					Female				
Sex-stratified	Log Haz	S.E	Z-score	P-value	Haz Ratio	Log Haz	S.E	Z-score	P-value	Haz Ratio
Period										
1991-2001	**0**				**1**	**0**				**1**
2001-2012	-0.13	0.01	-9.09	*0.00*	0.88	0.02	0.02	0.99	*0.32*	1.02
Ethnicity by country of birth										
White England and Wales	**0**				**1**	**0**				**1**
White Scottish	0.18	0.05	4.46	*0.00*	1.19	0.30	0.06	6.53	*0.00*	1.35
White Northern Irish	0.14	0.08	2.09	*0.04*	1.15	0.11	0.09	1.30	*0.20*	1.12
White Irish	0.02	0.04	0.53	*0.59*	1.02	0.08	0.05	1.62	*0.11*	1.08
Immigrants										
White	-0.19	0.03	-5.38	*0.00*	0.82	-0.24	0.03	-6.28	*0.00*	0.79
Indian	-0.16	0.04	-3.56	*0.00*	0.85	-0.24	0.04	-4.27	*0.00*	0.79
Pakistani	-0.36	0.04	-5.72	*0.00*	0.70	-0.34	0.06	-4.11	*0.00*	0.71
Bangladeshi	-0.38	0.07	-3.91	*0.00*	0.68	-0.93	0.06	-5.74	*0.00*	0.40
Chinese	-0.45	0.08	-3.71	*0.00*	0.64	-0.66	0.09	-3.68	*0.00*	0.52
Other Asian	-0.91	0.06	-6.49	*0.00*	0.40	-0.90	0.06	-5.66	*0.00*	0.41
Black Caribbean	-0.43	0.04	-6.34	*0.00*	0.65	-0.28	0.06	-3.58	*0.00*	0.76
Black African	-0.45	0.06	-4.53	*0.00*	0.64	-0.82	0.06	-5.65	*0.00*	0.44
Black Other	-0.04	0.21	-0.17	*0.86*	0.96	-0.18	0.22	-0.68	*0.49*	0.83
Mixed: Black/White	-0.56	0.16	-1.95	*0.05*	0.57	-0.16	0.24	-0.57	*0.57*	0.85
Mixed: Asian/White	-0.12	0.21	-0.49	*0.62*	0.89	-0.22	0.27	-0.66	*0.51*	0.80
Other	-0.48	0.08	-3.88	*0.00*	0.62	-0.81	0.07	-4.98	*0.00*	0.44
Descendants										
Indian	-0.07	0.21	-0.31	*0.76*	0.93	-0.25	0.25	-0.78	*0.44*	0.78
Pakistani & Bangladeshi	0.19	0.29	0.82	*0.41*	1.21	0.38	0.38	1.45	*0.15*	1.46
Chinese & Other Asian	-14.76	0.00	-0.02	*0.98*	0.00	-1.60	0.20	-1.60	*0.11*	0.20
Black Caribbean	0.56	0.31	3.19	*0.00*	1.75	0.51	0.32	2.62	*0.01*	1.66
Black African	-0.89	0.13	-2.80	*0.01*	0.41	-0.15	0.25	-0.51	*0.61*	0.86
Black Other	0.46	0.46	1.57	*0.12*	1.58	0.14	0.43	0.36	*0.72*	1.14
Mixed: Black/White	-0.40	0.16	-1.68	*0.09*	0.67	-0.16	0.20	-0.68	*0.49*	0.85
Mixed: Asian/White	-0.31	0.26	-0.87	*0.38*	0.73	-0.64	0.30	-1.12	*0.27*	0.53
Other	0.28	0.25	1.45	*0.15*	1.32	0.05	0.29	0.16	*0.87*	1.05
Occupation Type										
Professional/Managerial	**0**				**1**	**0**				**1**
Skilled	0.14	0.02	8.26	*0.00*	1.15	0.03	0.02	1.29	*0.20*	1.03
Unskilled	0.25	0.03	12.41	*0.00*	1.28	0.22	0.03	8.79	*0.00*	1.25
Missing	0.65	0.04	30.38	*0.00*	1.92	0.54	0.04	21.68	*0.00*	1.72
Education Level										
Degree level +	-0.33	0.02	-14.60	*0.00*	0.72	-0.30	0.02	-10.17	*0.00*	0.74
A-levels	0.00	0.03	-5.09	*0.00*	0.85	0.00	0.03	-4.63	*0.00*	0.82
No 18+ qualifications	**0**				**1**	**0**				**1**
Missing	0.08	0.12	0.71	*0.48*	1.08	-0.26	0.12	-1.72	*0.09*	0.77

Source: author's calculations based on ONS LS

Table E4 (continued)[76]

Model 2 Sex-stratified	**Male** Log Haz	S.E	Z-score	P-value	Haz Ratio	**Female** Log Haz	S.E	Z-score	P-value	Haz Ratio
Housing Tenure										
Owned	**0**				**1**	**0**				**1**
Private Renting	0.47	0.02	30.36	*0.00*	1.60	0.45	0.03	25.81	*0.00*	1.57
Social Renting	0.23	0.03	9.20	*0.00*	1.26	0.22	0.04	7.15	*0.00*	1.25
Missing	0.98	0.10	25.17	*0.00*	2.65	1.28	0.15	30.43	*0.00*	3.58
Area of Residence Type										
Rural	**0**				**1**	**0**				**1**
London	0.04	0.02	2.20	*0.03*	1.04	0.00	0.02	0.14	*0.89*	1.00
Other Urban	0.10	0.02	6.66	*0.00*	1.10	0.13	0.02	7.39	*0.00*	1.13
Marital Status										
Married	**0**				**1**	**0**				**1**
Single	0.43	0.03	23.35	*0.00*	1.53	0.32	0.04	12.29	*0.00*	1.38
Divorced	0.26	0.03	13.16	*0.00*	1.29	0.19	0.03	8.18	*0.00*	1.20
Widowed	0.21	0.03	8.47	*0.00*	1.23	0.10	0.02	5.09	*0.00*	1.10

Source: author's calculations based on ONS LS

[76] Male (constant) **0.00000194**; (SE) **0.0000000732**; (z-score) **-348.81**; (p-value) **0.00**; Male (gamma) **0.0079747**; (SE) **0.0000459**; (z-score) **173.87**; (p-value) **0.00**; Female (constant) **0.00000125**; (SE) **0.0000000592**; (z-score) **-287.59**; (p-value) **0.00**; Female (gamma) **0.0078561**; (SE) **0.0000567**; (z-score) **138.64**; (p-value) **0.00**

Table E5. Model 2 (sex-adjusted) with log relative hazard, standard errors, z-score and p-values for lowest level ethnic groups.[77]

Lowest level ethnic groups	SES				
	Log Haz	S.E	Z-score	P-value	Haz Ratio
Sex					
Male	**0**				**1**
Female	-0.53	0.01	-54.47	*0.00*	0.59
Period					
1991-2001	**0**				**1**
2001-2012	-0.07	0.01	-6.29	*0.00*	0.93
Ethnicity by country of birth					
White England and Wales	**0**				**1**
White Scottish	0.23	0.04	7.56	*0.00*	1.25
White Northern Irish	0.13	0.06	2.42	*0.02*	1.14
White Irish	0.05	0.03	1.58	*0.12*	1.05
Immigrants					
White	-0.22	0.02	-8.18	*0.00*	0.81
Indian	-0.19	0.03	-5.48	*0.00*	0.83
Pakistani	-0.36	0.04	-7.08	*0.00*	0.70
Bangladeshi	-0.55	0.05	-6.64	*0.00*	0.58
Chinese	-0.52	0.06	-5.14	*0.00*	0.60
Other Asian	-0.91	0.04	-8.63	*0.00*	0.40
Black Caribbean	-0.36	0.04	-7.15	*0.00*	0.70
Black African	-0.57	0.05	-7.01	*0.00*	0.56
Black Other	-0.09	0.15	-0.55	*0.58*	0.91
Mixed: Black/White	-0.37	0.14	-1.87	*0.06*	0.69
Mixed: Asian/White	-0.15	0.17	-0.78	*0.44*	0.86
Other	-0.62	0.05	-6.27	*0.00*	0.54
Descendants					
Indian	-0.13	0.16	-0.72	*0.47*	0.88
Pakistani	0.22	0.24	1.10	*0.27*	1.24
Bangladeshi	0.53	0.64	1.41	*0.16*	1.70
Chinese	-1.68	0.19	-1.68	*0.09*	0.19
Other Asian	-13.68	0.00	-0.03	*0.97*	0.00
Black Caribbean	0.53	0.22	4.07	*0.00*	1.70
Black African	-0.55	0.12	-2.58	*0.01*	0.58
Black Other	0.32	0.32	1.38	*0.17*	1.37
Mixed: Black/White	-0.29	0.12	-1.74	*0.08*	0.75
Mixed: Asian/White	-0.41	0.20	-1.37	*0.17*	0.66
Other	0.21	0.19	1.33	*0.18*	1.23

Source: author's calculations based on ONS LS

Note: The model is adjusted for occupation type, education level, housing tenure, area of residence type and marital status but the coefficients not shown (they are very similar to the values in the chapter).

[77] (constant) **0.00000199**; (SE) **0.0000000589**; (z-score) **-443.41**; (p-value) **0.00**; (gamma) **0.00793**; (SE) **0.0000356**; (z-score) **222.76**; (p-value) **0.00**

Table E6. Model 2b with log relative hazard, standard errors, z-score and p-values adjusting for Carstairs instead of housing tenure.

Model w/ Carstairs	**SES**				
	Log Haz	S.E	Z-score	P-value	Haz Ratio
Sex					
Male	**0**				**1**
Female	-0.54	0.01	-55.98	*0.00*	0.58
Period					
1991-2001	**0**				**1**
2001-2012	-0.06	0.01	-5.20	*0.00*	0.94
Ethnicity by country of birth					
White England and Wales	**0**				**1**
White Scottish	0.25	0.04	8.32	*0.00*	1.28
White Northern Irish	0.17	0.06	3.15	*0.00*	1.18
White Irish	0.06	0.03	2.00	*0.05*	1.06
Immigrants					
White	-0.19	0.02	-7.31	*0.00*	0.82
Indian	-0.28	0.03	-8.09	*0.00*	0.75
Pakistani	-0.44	0.03	-8.77	*0.00*	0.64
Bangladeshi	-0.49	0.05	-5.93	*0.00*	0.61
Chinese	-0.47	0.06	-4.66	*0.00*	0.63
Other Asian	-0.82	0.05	-7.76	*0.00*	0.44
Black Caribbean	-0.34	0.04	-6.78	*0.00*	0.71
Black African	-0.49	0.05	-6.00	*0.00*	0.61
Black Other	0.13	0.19	0.75	*0.45*	1.14
Mixed: Black/White	-0.25	0.16	-1.23	*0.22*	0.78
Mixed: Asian/White	-0.14	0.17	-0.73	*0.47*	0.87
Other	-0.51	0.06	-5.12	*0.00*	0.60
Descendants					
Indian	-0.25	0.14	-1.36	*0.17*	0.78
Pakistani & Bangladeshi	0.19	0.21	1.07	*0.29*	1.20
Chinese & Other Asian	-2.31	0.10	-2.31	*0.02*	0.10
Black Caribbean	0.54	0.22	4.13	*0.00*	1.71
Black African	-0.49	0.13	-2.31	*0.02*	0.61
Black Other	0.41	0.35	1.77	*0.08*	1.50
Mixed: Black/White	-0.18	0.14	-1.09	*0.28*	0.83
Mixed: Asian/White	-0.40	0.20	-1.32	*0.19*	0.67
Other	0.35	0.22	2.25	*0.03*	1.42

Source: author's calculations based on ONS LS

Table E6 (continued)[78]

Model w/ Carstairs	**SES**				
	Log Haz	S.E	Z-score	P-value	Haz Ratio
Occupation Type					
Professional/Managerial	**0**				**1**
Skilled	0.11	0.02	7.96	*0.00*	1.12
Unskilled	0.29	0.02	18.81	*0.00*	1.34
Missing	0.71	0.03	45.75	*0.00*	2.04
Education Level					
Degree level +	-0.33	0.01	-18.19	*0.00*	0.72
A-levels	0.00	0.02	-7.44	*0.00*	0.83
No 18+ qualifications	**0**				**1**
Missing	1.51	0.43	16.07	*0.00*	4.54
Carstairs Deprivation Index					
High	**0**				**1**
Middle	-0.29	0.01	-25.93	*0.00*	0.75
Low	-0.17	0.01	-13.56	*0.00*	0.84
Missing	-0.89	0.02	-18.49	*0.00*	0.41
Area of Residence Type					
Rural	**0**				**1**
London	-0.01	0.02	-0.39	*0.70*	0.99
Other Urban	0.05	0.01	4.40	*0.00*	1.05
Marital Status					
Married	**0**				**1**
Single	0.52	0.02	36.39	*0.00*	1.69
Divorced	0.33	0.02	22.73	*0.00*	1.39
Widowed	0.20	0.02	13.97	*0.00*	1.23

Source: author's calculations based on ONS LS

[78] (constant) **0.00000244**; (SE) **0.0000000745**; (z-score) **-422.95**; (p-value) **0.00**; (gamma) **0.0079738**; (SE) **0.0000357**; (z-score) **223.20**; (p-value) **0.00**

Table E7. Age interaction model and reference model with likelihood ratio test. Separate interaction terms for immigrants and descendants.[79]

	Comparison Model					**Interaction Model**				
	Log Haz	S.E	Z-score	P-value	Haz Ratio	Log Haz	S.E	Z-score	P-value	Haz Ratio
Sex										
Male	**0**				**1**	**0**				**1**
Female	-0.54	0.01	-45.92	0.00	0.58	-0.54	0.01	-45.92	0.00	0.58
Period										
1991-2001	**0**				**1**	**0**				**1**
2001-2012	-0.06	0.01	-4.09	0.00	0.95	-0.05	0.01	-4.03	0.00	0.95
Ethnicity										
White England and Wales	**0**				**1**	**0**				**1**
White Other UK and Ireland	0.04	0.02	1.85	0.06	1.04	0.04	0.02	1.86	0.06	1.04
Descendants	-0.08	0.06	-1.21	0.23	0.92	-0.65	0.22	-2.99	0.00	0.52
Immigrants	-0.31	0.02	-11.87	0.00	0.73	-0.31	0.13	-2.39	0.02	0.73
Occupation type										
Professional/Managerial	**0**				**1**	**0**				**1**
Skilled	0.13	0.02	7.77	0.00	1.14	0.13	0.02	7.77	0.00	1.14
Unskilled	0.32	0.03	17.46	0.00	1.38	0.32	0.02	17.45	0.00	1.38
Missing	0.76	0.04	39.00	0.00	2.14	0.76	0.02	39.04	0.00	2.14
Education level										
Degree level +	-0.30	0.02	-13.95	0.00	0.74	-0.30	0.02	-13.97	0.00	0.74
A-level	-0.14	0.03	-4.60	0.00	0.87	-0.14	0.03	-4.61	0.00	0.87
No 18+ qualifications	**0**				**1**	**0**				**1**
Carstairs Deprivation Index										
High tertile	**0**				**1**	**0**				**1**
Middle tertile	-0.21	0.01	-13.14	0.00	0.81	-0.21	0.02	-13.13	0.00	0.81
Low tertile	-0.30	0.01	-20.81	0.00	0.74	-0.30	0.01	-20.79	0.00	0.74
Area of residence type										
Rural	**0**				**1**	**0**				**1**
London	-0.03	0.02	-1.55	0.12	0.97	-0.03	0.02	-1.54	0.12	0.97
Other Urban	0.05	0.01	3.46	0.00	1.05	0.05	0.01	3.48	0.00	1.05
Marital Status										
Married	**0**				**1**	**0**				**1**
Single	0.54	0.03	31.75	0.00	1.72	0.54	0.02	31.78	0.00	0.54
Divorced	0.39	0.02	23.73	0.00	1.48	0.39	0.02	23.67	0.00	0.39
Widowed	0.32	0.03	14.20	0.00	1.37	0.32	0.02	14.23	0.00	0.32

Source: author's calculations based on ONS LS

Interaction term (immigrants): 0.00000085
Interaction term (descendants): 0.00112010
Likelihood ratio test (assumption comparison model nested in interaction model)
LR $chi^2(1) = 7.77$; Prob > $chi^2 = 0.0206$

[79] Comparison (constant) **0.00000239**; (SE) **0.0000000859**; (z-score) **-359.86**; (p-value) **0.00**; Comparison (gamma) **0.0078702**; (SE) **0.0000448**; (z-score) **175.61**; (p-value) **0.00**; Interaction (constant) **-12.93751**; (SE) **0.0367384**; (z-score) **-352.15**; (p-value) **0.00**; Interaction (gamma – descendant) **0.0011201**; (SE) **0.0003955**; (z-score) **2.83**; (p-value) **0.005**; Interaction (gamma – immigrants) **0.00000085**; (SE) **0.0001743**; (z-score) **0.00**; (p-value) **0.996;** Interaction (constant) **0.0078595**; (SE) **0.0000459**; (z-score) **171.05**; (p-value) **0.00**

Table E8. Values used to plot Figure 1 (below) calculated from interaction model (Table 7).

Age years	White UK-born			Descendants			Immigrants		
	Log Hazard	Hazard Rate	Haz Ratio	Log Hazard	Hazard Rate	Haz Ratio	Log Hazard	Hazard Rate	Haz Ratio
Start	-10.46	*0.0000*	**1.00**	-11.11	*0.0000*	**0.52**	-10.77	*0.0000*	**0.73**
20	-8.57	*0.0002*	**1.00**	-8.95	*0.0001*	**0.68**	-8.88	*0.0001*	**0.73**
21	-8.48	*0.0002*	**1.00**	-8.85	*0.0001*	**0.69**	-8.79	*0.0002*	**0.73**
22	-8.38	*0.0002*	**1.00**	-8.74	*0.0002*	**0.70**	-8.69	*0.0002*	**0.73**
23	-8.29	*0.0003*	**1.00**	-8.63	*0.0002*	**0.71**	-8.60	*0.0002*	**0.73**
24	-8.20	*0.0003*	**1.00**	-8.52	*0.0002*	**0.72**	-8.51	*0.0002*	**0.73**
25	-8.10	*0.0003*	**1.00**	-8.42	*0.0002*	**0.73**	-8.41	*0.0002*	**0.73**
26	-8.01	*0.0003*	**1.00**	-8.31	*0.0002*	**0.74**	-8.32	*0.0002*	**0.73**
27	-7.91	*0.0004*	**1.00**	-8.20	*0.0003*	**0.75**	-8.22	*0.0003*	**0.73**
28	-7.82	*0.0004*	**1.00**	-8.09	*0.0003*	**0.76**	-8.13	*0.0003*	**0.73**
29	-7.72	*0.0004*	**1.00**	-7.98	*0.0003*	**0.77**	-8.03	*0.0003*	**0.73**
30	-7.63	*0.0005*	**1.00**	-7.88	*0.0004*	**0.78**	-7.94	*0.0004*	**0.73**
31	-7.54	*0.0005*	**1.00**	-7.77	*0.0004*	**0.79**	-7.85	*0.0004*	**0.73**
32	-7.44	*0.0006*	**1.00**	-7.66	*0.0005*	**0.80**	-7.75	*0.0004*	**0.73**
33	-7.35	*0.0006*	**1.00**	-7.55	*0.0005*	**0.81**	-7.66	*0.0005*	**0.73**
34	-7.25	*0.0007*	**1.00**	-7.45	*0.0006*	**0.82**	-7.56	*0.0005*	**0.73**
35	-7.16	*0.0008*	**1.00**	-7.34	*0.0007*	**0.84**	-7.47	*0.0006*	**0.73**
36	-7.06	*0.0009*	**1.00**	-7.23	*0.0007*	**0.85**	-7.37	*0.0006*	**0.73**
37	-6.97	*0.0009*	**1.00**	-7.12	*0.0008*	**0.86**	-7.28	*0.0007*	**0.73**
38	-6.88	*0.0010*	**1.00**	-7.01	*0.0009*	**0.87**	-7.19	*0.0008*	**0.73**
39	-6.78	*0.0011*	**1.00**	-6.91	*0.0010*	**0.88**	-7.09	*0.0008*	**0.73**
40	-6.69	*0.0012*	**1.00**	-6.80	*0.0011*	**0.89**	-7.00	*0.0009*	**0.73**
41	-6.59	*0.0014*	**1.00**	-6.69	*0.0012*	**0.91**	-6.90	*0.0010*	**0.73**
42	-6.50	*0.0015*	**1.00**	-6.58	*0.0014*	**0.92**	-6.81	*0.0011*	**0.73**
43	-6.40	*0.0017*	**1.00**	-6.48	*0.0015*	**0.93**	-6.71	*0.0012*	**0.73**
44	-6.31	*0.0018*	**1.00**	-6.37	*0.0017*	**0.94**	-6.62	*0.0013*	**0.73**
45	-6.22	*0.0020*	**1.00**	-6.26	*0.0019*	**0.96**	-6.53	*0.0015*	**0.73**
46	-6.12	*0.0022*	**1.00**	-6.15	*0.0021*	**0.97**	-6.43	*0.0016*	**0.73**
47	-6.03	*0.0024*	**1.00**	-6.04	*0.0024*	**0.98**	-6.34	*0.0018*	**0.73**
48	-5.93	*0.0027*	**1.00**	-5.94	*0.0026*	**1.00**	-6.24	*0.0019*	**0.73**
49	-5.84	*0.0029*	**1.00**	-5.83	*0.0029*	**1.01**	-6.15	*0.0021*	**0.73**
50	-5.74	*0.0032*	**1.00**	-5.72	*0.0033*	**1.02**	-6.05	*0.0023*	**0.73**
51	-5.65	*0.0035*	**1.00**	-5.61	*0.0036*	**1.04**	-5.96	*0.0026*	**0.73**
52	-5.55	*0.0039*	**1.00**	-5.51	*0.0041*	**1.05**	-5.86	*0.0028*	**0.73**
53	-5.46	*0.0043*	**1.00**	-5.40	*0.0045*	**1.06**	-5.77	*0.0031*	**0.73**
54	-5.37	*0.0047*	**1.00**	-5.29	*0.0050*	**1.08**	-5.68	*0.0034*	**0.73**
55	-5.27	*0.0051*	**1.00**	-5.18	*0.0056*	**1.09**	-5.58	*0.0038*	**0.73**
56	-5.18	*0.0056*	**1.00**	-5.07	*0.0063*	**1.11**	-5.49	*0.0041*	**0.73**
57	-5.08	*0.0062*	**1.00**	-4.97	*0.0070*	**1.12**	-5.39	*0.0045*	**0.73**
58	-4.99	*0.0068*	**1.00**	-4.86	*0.0078*	**1.14**	-5.30	*0.0050*	**0.73**
59	-4.89	*0.0075*	**1.00**	-4.75	*0.0086*	**1.15**	-5.20	*0.0055*	**0.73**
60	-4.80	*0.0082*	**1.00**	-4.64	*0.0096*	**1.17**	-5.11	*0.0060*	**0.73**
61	-4.71	*0.0090*	**1.00**	-4.54	*0.0107*	**1.19**	-5.02	*0.0066*	**0.73**
62	-4.61	*0.0099*	**1.00**	-4.43	*0.0119*	**1.20**	-4.92	*0.0073*	**0.73**
63	-4.52	*0.0109*	**1.00**	-4.32	*0.0133*	**1.22**	-4.83	*0.0080*	**0.73**
64	-4.42	*0.0120*	**1.00**	-4.21	*0.0148*	**1.23**	-4.73	*0.0088*	**0.73**
65	-4.33	*0.0132*	**1.00**	-4.10	*0.0165*	**1.25**	-4.64	*0.0097*	**0.73**
66	-4.23	*0.0145*	**1.00**	-4.00	*0.0184*	**1.27**	-4.54	*0.0106*	**0.73**
67	-4.14	*0.0159*	**1.00**	-3.89	*0.0205*	**1.29**	-4.45	*0.0117*	**0.73**
68	-4.05	*0.0175*	**1.00**	-3.78	*0.0228*	**1.30**	-4.36	*0.0128*	**0.73**
69	-3.95	*0.0192*	**1.00**	-3.67	*0.0254*	**1.32**	-4.26	*0.0141*	**0.73**
70	-3.86	*0.0211*	**1.00**	-3.57	*0.0283*	**1.34**	-4.17	*0.0155*	**0.73**
71	-3.76	*0.0232*	**1.00**	-3.46	*0.0315*	**1.36**	-4.07	*0.0170*	**0.73**
72	-3.67	*0.0255*	**1.00**	-3.35	*0.0351*	**1.37**	-3.98	*0.0187*	**0.73**
73	-3.57	*0.0280*	**1.00**	-3.24	*0.0391*	**1.39**	-3.88	*0.0206*	**0.73**
74	-3.48	*0.0308*	**1.00**	-3.13	*0.0435*	**1.41**	-3.79	*0.0226*	**0.73**
75	-3.39	*0.0339*	**1.00**	-3.03	*0.0484*	**1.43**	-3.70	*0.0248*	**0.73**
76	-3.29	*0.0372*	**1.00**	-2.92	*0.0540*	**1.45**	-3.60	*0.0273*	**0.73**
77	-3.20	*0.0409*	**1.00**	-2.81	*0.0601*	**1.47**	-3.51	*0.0300*	**0.73**
78	-3.10	*0.0449*	**1.00**	-2.70	*0.0669*	**1.49**	-3.41	*0.0330*	**0.73**
79	-3.01	*0.0494*	**1.00**	-2.60	*0.0746*	**1.51**	-3.32	*0.0362*	**0.73**
80	-2.91	*0.0542*	**1.00**	-2.49	*0.0830*	**1.53**	-3.22	*0.0398*	**0.73**

Source: author's calculations based on ONS LS

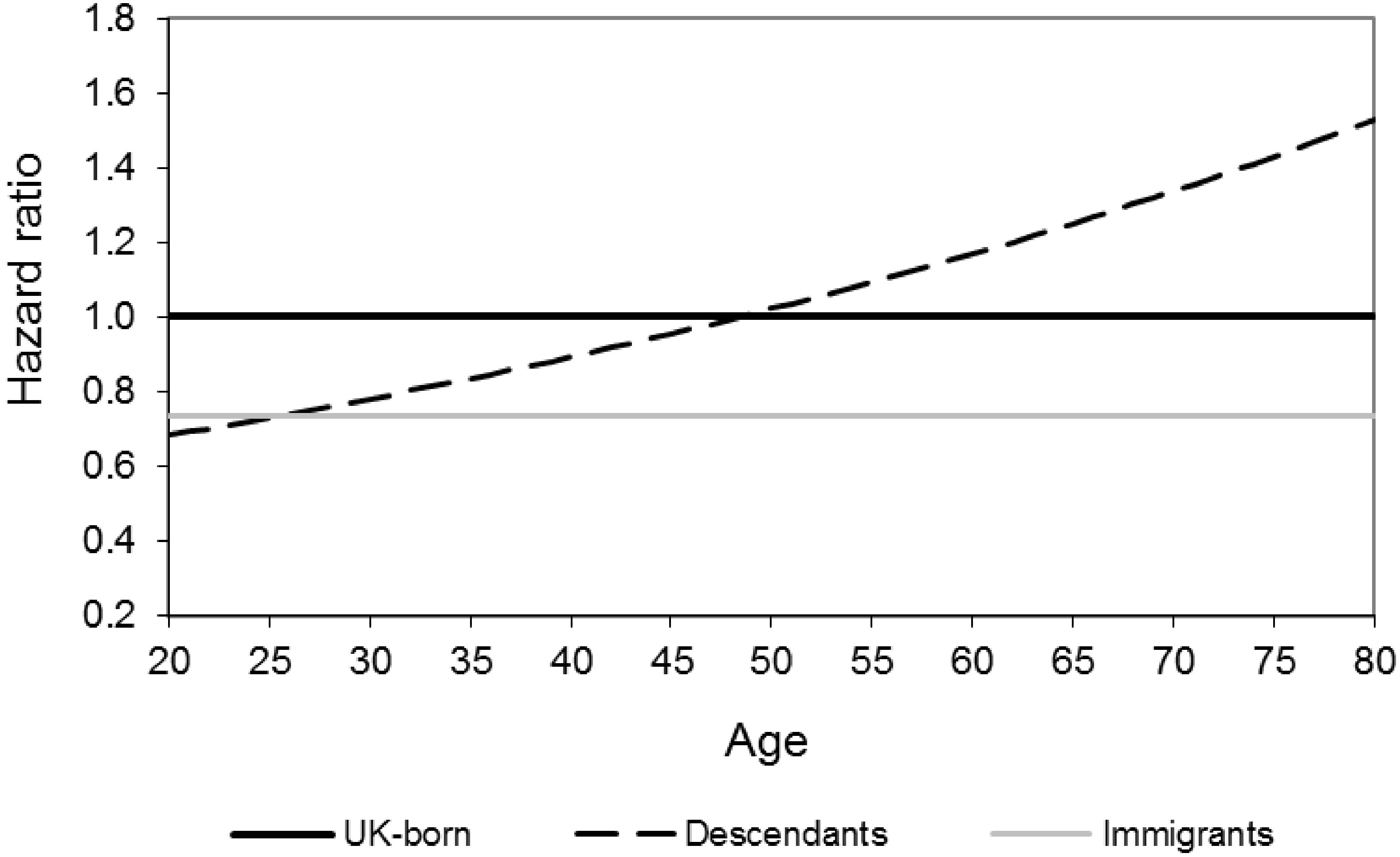

Figure E1. Plot of age interactions for immigrants and their descendants relative to White born in England and Wales.

Source: author's calculations based on ONS LS

Table E9. Interactions models: ethnicity with occupation type/education level.

Interactions	Occupation type					Education level				
	Log Haz	S.E	Z-Score	P-value	Haz Ratio	Log Haz	S.E	Z-Score	P-value	Haz Ratio
Sex										
Male	**0**				**1**	**0**				**1**
Female	-0.51	0.01	-43.96	*0.00*	0.60	-0.54	0.01	-46.20	*0.00*	0.58
Period										
1991-2001	**0**				**1**	**0**				**1**
2001-2012	-0.08	0.01	-6.11	*0.00*	0.92	-0.07	0.01	-4.92	*0.00*	0.94
Ethnicity										
White UK-born (High)	**0**				**1**	**0**				**1**
White UK-born (Low)	0.41	0.02	33.23	*0.00*	1.51	0.25	0.03	12.75	*0.00*	1.28
Immigrants										
White (High)	-0.14	0.04	-3.05	*0.00*	0.87	-0.28	0.06	-3.81	*0.00*	0.76
White (Low)	0.19	0.06	3.71	*0.00*	1.21	0.08	0.05	1.89	*0.06*	1.08
Indian (High)	-0.16	0.05	-2.63	*0.01*	0.85	-0.26	0.07	-2.68	*0.01*	0.77
Indian (Low)	0.19	0.06	3.70	*0.00*	1.21	0.02	0.05	0.34	*0.73*	1.02
Pakistani and Bangladeshi (High)	-0.21	0.07	-2.45	*0.01*	0.81	-0.42	0.11	-2.56	*0.01*	0.66
Pakistani and Bangladeshi (Low)	0.12	0.06	2.24	*0.03*	1.13	-0.12	0.05	-2.32	*0.02*	0.88
Chinese and Other Asian (High)	-0.44	0.07	-3.95	*0.00*	0.65	-0.44	0.11	-2.64	*0.01*	0.65
Chinese and Other Asian (Low)	-0.24	0.09	-2.01	*0.04*	0.78	-0.40	0.06	-4.16	*0.00*	0.67
Black Caribbean (High)	-0.16	0.08	-1.64	*0.10*	0.86	-0.42	0.12	-2.39	*0.02*	0.66
Black Caribbean (Low)	-0.05	0.08	-0.63	*0.53*	0.95	-0.10	0.06	-1.53	*0.13*	0.90
Black African and Black Other (High)	-0.17	0.10	-1.44	*0.15*	0.84	0.18	0.17	1.28	*0.20*	1.20
Black African and Black Other (Low)	-0.02	0.11	-0.16	*0.87*	0.98	-0.28	0.08	-2.83	*0.01*	0.75
Other (High)	-0.14	0.11	-1.08	*0.28*	0.87	-0.15	0.15	-0.85	*0.39*	0.86
Other (Low)	0.06	0.14	0.44	*0.66*	1.06	-0.11	0.10	-1.02	*0.31*	0.90
Descendants										
Indian (High)	-0.27	0.22	-0.95	*0.34*	0.76	-0.43	0.26	-1.06	*0.29*	0.65
Indian (Low)	0.10	0.28	0.38	*0.70*	1.10	-0.12	0.19	-0.57	*0.57*	0.88
Pakistani and Bangladeshi (High)	0.10	0.39	0.29	*0.77*	1.11	0.23	0.51	0.56	*0.58*	1.26
Pakistani and Bangladeshi (Low)	0.52	0.38	2.32	*0.02*	1.68	0.15	0.25	0.71	*0.48*	1.16
Chinese and Other Asian (High)	-1.26	0.28	-1.26	*0.21*	0.28	-12.88	0.00	-0.03	*0.98*	0.00
Chinese and Other Asian (Low)	-14.77	0.00	-0.02	*0.99*	0.00	-1.84	0.16	-1.84	*0.07*	0.16
Black Caribbean (High)	0.51	0.30	2.76	*0.01*	1.66	0.21	0.44	0.60	*0.55*	1.24
Black Caribbean (Low)	0.95	0.52	4.72	*0.00*	2.58	0.80	0.33	5.39	*0.00*	2.22
Black African and Black Other (High)	-0.12	0.20	-0.56	*0.58*	0.88	0.28	0.44	0.85	*0.40*	1.33
Black African and Black Other (Low)	-0.09	0.24	-0.34	*0.74*	0.91	-0.23	0.16	-1.15	*0.25*	0.79
Other (High)	-0.36	0.15	-1.75	*0.08*	0.69	0.27	0.31	1.15	*0.25*	1.31
Other (Low)	0.61	0.26	4.40	*0.00*	1.85	0.10	0.15	0.76	*0.45*	1.11

Source: author's calculations based on ONS LS

Table E9 (continued).[80]

Interactions	Occupation type					Education level				
	Log Haz	S.E	Z-Score	P-value	Haz Ratio	Log Haz	S.E	Z-Score	P-value	Haz Ratio
Education level										
Degree level +	-0.34	0.01	-16.97	*0.00*	0.71	*(Education modelled as interaction with ethnicity)*				
A-level	-0.16	0.02	-5.57	*0.00*	0.85					
No 18+ qualifications	**0**				**1**					
Missing	-1.81	0.12	-2.54	*0.01*	0.16					
Occupation type										
Professional/Managerial	*(Occupation modelled as interaction with ethnicity)*					**0**				**1**
Skilled						0.14	0.02	8.33	*0.00*	1.15
Unskilled						0.33	0.03	18.07	*0.00*	1.39
Missing						0.77	0.04	40.01	*0.00*	2.16
Carstairs Deprivation Index										
High deprivation tertile	**0**				**1**	**0**				**1**
Middle deprivation tertile	-0.21	0.01	-13.82	*0.00*	0.81	-0.21	0.01	-13.36	*0.00*	0.81
Low deprivation tertile	-0.31	0.01	-21.55	*0.00*	0.73	-0.30	0.01	-20.92	*0.00*	0.74
Missing	1.27	0.27	16.76	*0.00*	3.55	1.23	0.26	16.27	*0.00*	3.42
Area of Residence type										
Rural	**0**				**1**	**0**				**1**
London	0.00	0.02	-0.25	*0.80*	1.00	-0.01	0.02	-0.65	*0.52*	0.99
Other Urban	0.05	0.01	3.79	*0.00*	1.05	0.05	0.01	3.42	*0.00*	1.05
Missing	-1.20	0.21	-1.68	*0.09*	0.30	-1.30	0.19	-1.83	*0.07*	0.27
Marital Status										
Married	**0**				**1**	**0**				**1**
Single	0.58	0.03	34.50	*0.00*	1.78	0.54	0.03	31.79	*0.00*	1.71
Divorced	0.41	0.02	24.81	*0.00*	1.50	0.39	0.02	23.75	*0.00*	1.48
Widowed	0.34	0.03	15.55	*0.00*	1.41	0.32	0.03	14.28	*0.00*	1.37
Missing	*(omitted)*					*(omitted)*				

Source: author's calculations based on ONS LS

Notes: Occupation type is coded to high (0=professional/managerial) and low (1=unskilled and missing); Education level coded to high (0=degree level/A-level) and low (0=no 18+ quals and missing).

Likelihood ratio test (model 3 nested in interaction models)

Occupation type: *LR* $chi^2(13) = 22.22$; *Prob* > $chi^2 = 0.0520$

Education level: *LR* $chi^2(13) = 27.57$; *Prob* > $chi^2 = 0.0104$

[80] Occupation type (constant) **0.000002490**; (SE) **0.00000008460**; (z-score) **-380.11**; (p-value) **0.00**; Occupation type (gamma) **0.0079381**; (SE) **0.0000447**; (z-score) **177.55**; (p-value) **0.00**; Education level (constant) **0.000001830**; (SE) **0.00000006770**; (z-score) **-357.58**; (p-value) **0.00**; Education level (gamma) **0.0079074**; (SE) **0.0000444**; (z-score) **177.97**; (p-value) **0.00**

Table E10. Sensitivity tests: effect of changing upper age limit on hazard ratios for immigrants and descendants.[81]

Sensitivity to different age designs	20 to (40 years + 1 year each year)					20 to 60 years					20 to (60 years + 1 year each year)					0 to (60 years + 1 year each year)				
	Log Haz	S.E	Z-Score	P-value	Haz Ratio	Log Haz	S.E	Z-Score	P-value	Haz Ratio	Log Haz	S.E	Z-Score	P-value	Haz Ratio	Log Haz	S.E	Z-Score	P-value	Haz Ratio
Sex																				
Male	**0**				**1**	**0**				**1**	**0**				**1**	**0**				**1**
Female	-0.50	0.02	-19.49	*0.00*	0.61	-0.54	0.01	-45.92	*0.00*	0.58	-0.54	0.01	-46.17	*0.00*	0.58	-0.54	0.01	-56.23	*0.00*	0.58
Period																				
1991-2001	**0**				**1**	**0**				**1**	**0**				**1**	**0**				**1**
2001-2011	-0.03	0.03	-0.99	*0.32*	0.97	-0.06	0.01	-4.09	*0.00*	0.95	-0.05	0.01	-3.75	*0.00*	0.95	-0.06	0.01	-5.96	*0.00*	0.94
Ethnicity by country of birth																				
White England and Wales	**0**				**1**	**0**				**1**	**0**				**1**	**0**				**1**
White Other UK and Ireland	-0.17	0.07	-2.15	*0.03*	0.84	-0.08	0.06	-1.21	*0.23*	0.92	-0.11	0.06	-1.51	*0.13*	0.90	0.16	0.02	7.74	*0.00*	1.17
Immigrants	-0.31	0.04	-5.79	*0.00*	0.73	-0.31	0.02	-11.87	*0.00*	0.73	-0.31	0.02	-12.26	*0.00*	0.73	-0.31	0.01	-17.39	*0.00*	0.73
Descendants	-0.06	0.05	-1.12	*0.26*	0.94	0.04	0.02	1.85	*0.06*	1.04	0.04	0.02	1.74	*0.08*	1.04	0.01	0.06	0.12	*0.91*	1.01
Occupation Type																				
Professional/Managerial	**0**				**1**	**0**				**1**	**0**				**1**	**0**				**1**
Skilled	0.18	0.04	4.89	*0.00*	1.20	0.13	0.02	7.77	*0.00*	1.14	0.13	0.02	7.91	*0.00*	1.14	0.11	0.02	7.97	*0.00*	1.12
Unskilled	0.48	0.07	11.64	*0.00*	1.61	0.32	0.03	17.46	*0.00*	1.38	0.32	0.03	17.69	*0.00*	1.38	0.29	0.02	18.65	*0.00*	1.33
Missing	1.04	0.12	23.96	*0.00*	2.82	0.76	0.04	39.00	*0.00*	2.14	0.76	0.04	39.48	*0.00*	2.15	0.71	0.03	45.75	*0.00*	2.03
Education Level																				
Degree level +	-0.37	0.03	-8.21	*0.00*	0.69	-0.30	0.02	-13.95	*0.00*	0.74	-0.30	0.02	-14.04	*0.00*	0.74	-0.33	0.01	-18.09	*0.00*	0.72
A-level	-0.26	0.04	-4.43	*0.00*	0.77	-0.14	0.03	-4.60	*0.00*	0.87	-0.13	0.03	-4.55	*0.00*	0.87	-0.19	0.02	-7.42	*0.00*	0.83
No 18+ qualifications	**0**				**1**	**0**				**1**	**0**				**1**	**0**				**1**
Marital Status																				
Married	**0**				**1**	**0**				**1**	**0**				**1**	**0**				**1**
Single	0.64	0.06	20.23	*0.00*	1.89	0.54	0.03	31.75	*0.00*	1.72	0.54	0.03	31.82	*0.00*	1.71	0.53	0.02	36.85	*0.00*	1.69
Divorced	0.45	0.06	11.93	*0.00*	1.56	0.39	0.02	23.73	*0.00*	1.48	0.39	0.02	23.77	*0.00*	1.48	0.33	0.02	23.05	*0.00*	1.40
Widowed	0.51	0.21	3.93	*0.00*	1.66	0.32	0.03	14.20	*0.00*	1.37	0.32	0.03	14.30	*0.00*	1.37	0.21	0.02	14.07	*0.00*	1.23
Carstairs Deprivation Index																				
High tertile	**0**				**1**	**0**				**1**	**0**				**1**	**0**				**1**
Middle tertile	-0.19	0.03	-5.52	*0.00*	0.82	-0.21	0.01	-13.14	*0.00*	0.81	-0.21	0.01	-13.31	*0.00*	0.81	-0.17	0.01	-13.45	*0.00*	0.84
Low tertile	-0.26	0.03	-7.89	*0.00*	0.77	-0.30	0.01	-20.81	*0.00*	0.74	-0.30	0.01	-20.88	*0.00*	0.74	-0.29	0.01	-25.71	*0.00*	0.75
Area of Residence Type																				
Rural	**0**				**1**	**0**				**1**	**0**				**1**	**0**				**1**
London	-0.06	0.04	-1.58	*0.11*	0.94	-0.03	0.02	-1.55	*0.12*	0.97	-0.03	0.02	-1.53	*0.13*	0.97	-0.02	0.02	-1.19	*0.23*	0.98
Other Urban	-0.01	0.03	-0.20	*0.84*	0.99	0.05	0.01	3.46	*0.00*	1.05	0.05	0.01	3.51	*0.00*	1.05	0.05	0.01	3.93	*0.00*	1.05

Source: author's calculations based on ONS LS

[81] 20-40 + 1 (constant) **0.000001610**; (SE) **0.0000001310**; (z-score) **-163.55**; (p-value) **0.00**; 20-40 + 1 (gamma) **0.0082896**; (SE) **0.0000134**; (z-score) **61.85**; (p-value) **0.00**; 20-60 (constant) **0.000002390**; (SE) **0.00000008590**; (z-score) **-359.86**; (p-value) **0.00**; 20-60 (gamma) **0.0078702**; (SE) **0.0000448**; (z-score) **175.61**; (p-value) **0.00;** 20-60 + 1 (constant) **0.000002360**; (SE) **0.00000008440**; (z-score) **-361.73**; (p-value) **0.00**; 20-60 + 1 (gamma) **0.0078887**; (SE) **0.0000446**; (z-score) **176.75**; (p-value) **0.00**; 0-60+1 (constant) **0.000002350**; (SE) **0.00000008400**; (z-score) **-362.90**; (p-value) **0.00**; 0-60+1 (gamma) **0.0079107**; (SE) **0.0000444**; (z-score) **178.08**; (p-value) **0.00;**

Table E11. Multilevel logistic regression model: limiting long-term illness as a proxy for mortality, 1991-2011

Multilevel LLTI model	1991-2011				
	SES				
	Log Odds	S.E	Z-score	P-value	Odds Ratio
Sex					
Male	**0**				**1**
Female	-0.07	0.01	-6.00	*0.00*	0.93
Age (years)					
20-24	-2.41	0.00	-86.61	*0.00*	0.09
25-29	-1.67	0.00	-63.56	*0.00*	0.19
30-34	-1.07	0.01	-49.51	*0.00*	0.34
35-39	0.00	0.01	-23.62	*0.00*	0.59
40-44	**0**				**1**
45-49	0.50	0.03	24.00	*0.00*	1.65
50-54	1.20	0.06	64.18	*0.00*	3.30
55-59	1.82	0.13	84.14	*0.00*	6.17
60-64	2.69	0.34	117.81	*0.00*	14.71
65-69	3.10	0.56	121.50	*0.00*	22.11
70-74	3.73	1.27	121.91	*0.00*	41.43
75+	4.59	3.37	133.06	*0.00*	97.79
Ethnicity					
White England and Wales	**0**				**1**
Immigrants					
White	-0.26	0.02	-11.17	*0.00*	0.77
India	0.29	0.05	7.59	*0.00*	1.33
Pakistan/Bangladesh	0.82	0.09	21.14	*0.00*	2.26
Black Caribbean	-0.31	0.04	-5.39	*0.00*	0.74
Black African/Other	-0.26	0.06	-3.34	*0.00*	0.77
China/Other Asia	-0.54	0.03	-9.65	*0.00*	0.58
Other	0.15	0.07	2.29	*0.02*	1.16
Black Caribbean					
Descendants					
India	0.05	0.10	0.51	*0.61*	1.05
Pakistan/Bangladesh	0.94	0.23	10.49	*0.00*	2.55
Black Caribbean	0.15	0.13	1.40	*0.16*	1.16
Black African/Other	0.18	0.12	1.83	*0.07*	1.19
China/Other Asia	-0.23	0.15	-1.22	*0.22*	0.79
Other	0.50	0.12	6.66	*0.00*	1.65

Source: author's calculations based on ONS LS

Table E11 (continued)[82]

Multilevel LLTI model	1991-2011				
	SES				
	Log Odds	S.E	Z-score	P-value	Odds Ratio
Occupation type					
Professional/Managerial	**0**				**1**
Skilled	0.41	0.02	29.53	*0.00*	1.51
Unskilled	0.82	0.04	51.65	*0.00*	2.27
Missing	1.69	0.10	91.96	*0.00*	5.39
Education Level					
No 18+ Qualifications	**0**				**1**
A-level	-0.62	0.01	-39.88	*0.00*	0.54
Degree Level +	-0.46	0.01	-24.38	*0.00*	0.63
Marital Status					
Married	**0**				**1**
Single	1.12	0.05	67.92	*0.00*	3.07
Divorced	0.72	0.03	43.60	*0.00*	2.05
Widowed	0.73	0.04	41.65	*0.00*	2.06

Source: author's calculations based on ONS LS

[82] (constant) **-4.415539**; (SE) **0.0320901**; (z-score) **-137.60**; (p-value) **0.00** (/lnsig2u) **1.751102**; (SE) **0.129781**; (sigma_u) **2.400197**; (SE) **0.015575;** (rho) **0.6365114**; (SE) **0.0030027**

Appendix F: Frailty

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Table F1. Survival model with unshared frailty (Inverse-Gaussian frailty model).[83]

Unshared Frailty	SES				
	Log Haz	S.E	Z-score	P-value	Haz Ratio
Sex					
Male	**0**				**1**
Female	-0.58	0.01	-42.23	*0.00*	0.56
Period					
1991-2001	**0**				**1**
2001-2012	-0.04	0.01	-2.84	*0.01*	0.96
Ethnicity by country of birth					
Immigrants					
White England and Wales	**0**				**1**
Indian	-0.24	0.03	-5.50	*0.00*	0.79
Pakistani	-0.32	0.04	-5.54	*0.00*	0.72
Bangladeshi	-0.54	0.06	-5.37	*0.00*	0.59
Chinese	-0.39	0.08	-3.23	*0.00*	0.68
Other Asian	-0.74	0.06	-5.98	*0.00*	0.48
Black Caribbean	-0.36	0.05	-5.21	*0.00*	0.70
Black African	-0.43	0.06	-4.37	*0.00*	0.65
Black Other	0.22	0.28	0.97	*0.33*	1.24
Other	-0.31	0.07	-3.10	*0.00*	0.74
White (inc Other UK/Ireland)	0.04	0.02	1.66	*0.10*	1.04
Occupation Type					
Professional/Managerial	**0**				**1**
Skilled	0.14	0.02	7.88	*0.00*	1.15
Unskilled	0.35	0.03	17.45	*0.00*	1.41
Missing	0.84	0.06	35.44	*0.00*	2.33
Education Level					
Degree level +	0.00	0.02	-14.06	*0.00*	0.72
A-levels	0.00	0.03	-4.49	*0.00*	0.87
No 18+ qualifications	**0**				**1**
Carstairs Deprivation Index					
High	**0**				**1**
Middle	-0.32	0.01	-20.45	*0.00*	0.72
Low	-0.22	0.01	-13.19	*0.00*	0.80
Area of Residence Type					
Rural	**0**				**1**
London	-0.03	0.02	-1.56	*0.12*	0.97
Other Urban	0.05	0.02	3.35	*0.00*	1.05
Marital Status					
Married	**0**				**1**
Single	0.60	0.04	29.55	*0.00*	1.82
Divorced	0.42	0.03	22.96	*0.00*	1.52
Widowed	0.35	0.04	13.79	*0.00*	1.42

Source: author's calculations based on ONS LS

[83] (constant) **0.00000179**; (SE) **0.0000000973**; (z-score) **-243.73**; (p-value) **0.00**; (/gamma) **0.0083491**; (SE) **0.0000821**; (z-score) **101.69**; (p-value) **0.00**; (/ln_the) **-0.628449**; (SE) **0.1723551**; (z-score) **-3.65**; (p-value) **0.00;** (theta) **0.5334185**; (SE) **0.919374**